2011

Perspective Shifting in Relative Clauses by Elementary-Aged Spanish-English Bilinguals: A Cross-Linguistic Study

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Perspective Shifting in Relative Clauses by Elementary-Aged Spanish-English Bilinguals:

A Cross-Linguistic Study

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science
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Date of Approval:
July 8, 2011

Keywords:
syntax processing, bilingualism, relative clauses, perspective shifting, Mouse Tracker

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Acknowledgments

There are several individuals who have been instrumental in the successful completion of this thesis. I owe my deepest gratitude to Dr. Ruth Huntley Bahr, whose guidance, support, and patience allowed me to gain a greater knowledge and passion for the research process. Her mentorship opened my eyes to my potential as a future researcher.

I am also indebted to Dr. Maria Brea-Spahn and Dr. Robin Danzak, who shared their expertise and provided insightful commentary that challenged me to think deeper and ask more questions.

I would also like to extend my gratitude to Dr. Elaine Silliman, who collaborated during the conceptual development of this study, and whose recommendations were also key in the improvement of my thesis. The mentorship she has provided me with throughout the years has been both life changing and inspiring.

This thesis would not have been possible without the selfless dedication of Ms. Diana Rosero, who was instrumental during the processes of data collection and data analysis. I am eternally grateful for her friendship and encouragement.

I am also grateful to Mrs. Kyna Betancourt, who helped me understand and apply the signal detection theory. The information she provided me helped me improve the quality of my research study.

I also owe thanks to Mrs. Mabel Atez, whose preliminary study investigating perspective shifting in bilingual children’s relative clause processing set the foundation for the current study.

Last, but, certainly, not least, I am thankful for my family and friends, who provided endless encouragement and support. I could not have completed my thesis without them.
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Abstract

Language-specific theories of sentence processing suggest that individuals interpret sentences based on the characteristics of their native language (e.g., Bates & MacWhinney, 1989). As such, competing linguistic cues are taken into account (including word order, morphology, and animacy) and the cue selected is most likely to yield a correct interpretation in the native language. However, research in this area has produced conflicting results. MacWhinney (2005) has proposed that examining the role of perspective shifting in sentence comprehension may demonstrate how cognitive and syntactic factors work together to facilitate sentence comprehension. The aim of the current study is to investigate the role of perspective shifting in the processing of relative clauses by bilingual children.

A total of 16 bilingual and 13 monolingual children in grades 3 and 5 participated in this study. Difficulty in Spanish and English sentence processing was assessed using four types of relative clauses, that varied in the complexity of perspective shift, and a control sentence. A sentence comprehension task was devised using Mouse Tracker software (Freeman & Ambady, 2010) to assess the participant’s ability to identify whether or not the presented picture reflected the relationship described in the oral sentence presentation. Difficulty in sentence processing was determined using measures
of accuracy (percent correct and d’) and response time (RT). Data were compared across languages for the bilingual children and with an monolingual English control group.

MANOVA results revealed a significant main effect for sentence type and no effect of language in all analyses. Hence, bilingual participant performance on the sentence processing task was similar across languages and across language groups when compared to those monolingual English speakers. In general, accuracy levels and d’ values were greater for the 0 switch and control conditions. RTs were longer for the more complex relative clauses. The 1+ condition consistently appeared to be the most difficult. These findings indicate that participants processed the relative clauses in a similar way across languages and that more complex perspective shifts resulted in poorer performance.

These results suggest that perspective shifting is a relevant factor in syntax comprehension, but that the number of perspective shifts is less important. Instead, the direction of perspective shift and the role of the relative clause (subject versus object-modifying) seem to be more essential. These results support the Unified Competition Model (MacWhinney, 2005b) by demonstrating the use of shared cognitive processes across languages. However, one cannot rule out the role of language dominance and language structure in relative clause processing as the sentences in this experiment maintained parallel syntactic structures across languages. Clinical and educational implications are provided.
Chapter 1

Literature Review

Introduction

A significant controversy in developmental language processing is whether bilingual individuals process sentences, in the same way, or differently, than their monolingual counterparts (Dussias, 2004; Fernandez, 2002; MacWhinney, 2005). Comparing how bilingual speakers process aspects of syntax in their first and second languages may help to clarify how language experiences affect oral language processing. One way to investigate how bilingual individuals process syntax is by examining their comprehension of relative clauses.

Historically, researchers have found that relative clauses lead to various degrees of comprehension difficulty in monolingual adults (Cuetos & Mitchell, 1988; De Vincenzi & Job, 1993; Frazier & Rayner, 1982; Mak, Weitske, & Schriefers, 2006), bilingual adults (Dussias, 2004; Fernandez, 2002), and English-speaking monolingual children (Weighall & Altmann, 2010). Decrements in understanding have been attributed to several factors, including word order (Cuetos & Mitchell, 1988; Frazier & Rayner, 1982), memory deficits, (Domenico & Matteo, 2009; Felser, Marinis, & Clahsen, 2003) and animacy conflicts (Mak et al., 2006; Traxler, Morris, & Seely, 2002). However, there
is limited research that has investigated the role of perspective shifting in individuals’ relative clause processing (Jones, 2010; MacWhinney & Pleh, 1988; Wilkinson, Silliman, Bahr, & Danzak, 2008). MacWhinney (2005) proposed that examining the role of perspective shifting in sentence comprehension may help understand how cognitive factors and syntax may work together to facilitate sentence comprehension. The aim of the current study is to investigate the role of perspective shifting in the processing of relative clauses (MacWhinney, 2005) by bilingual children. MacWhinney suggested that language processing also occurred at a cognitive level and that individuals needed to take the perspective of others when processing relative clause sentences. According to the Perspective Hypothesis, comprehension breakdowns occur when an individual is not able to shift perspectives adequately. In addition, McWhinney argued that relative clauses requiring multiple shifts in perspectives will yield the most difficulties in comprehension.

The Perspective Hypothesis (MacWhinney, 2005) has been used to investigate relative clause processing by monolingual speakers in English (MacWhinney & Bates, 1989) and Hungarian (MacWhinney & Pleh, 1988); however, only one preliminary study has examined the role of perspective taking in the processing of relative clauses by individuals who are bilingual (Wilkinson et al., 2008). In the current investigation, the role of perspective shifting in bilingual children’s comprehension of sentences containing relative clauses will be examined; thus, allowing for within-subject comparisons and reducing the variability found when comparing groups of participants across different studies.
The literature review will begin with an examination of sentence processing in bilingual speakers. Then, various accounts on relative clause processing will be reviewed. Finally, the purpose on the current study will be defined.

**Bilingual Sentence Processing**

One of the major debates in bilingual research is whether individuals who are bilingual use the same strategies as their monolingual counterparts to comprehend sentences in their first (L1) and second language (L2) (Dussias, 2004; Bates & MacWhinney, 1989). Language-specific theories of sentence processing, such as the Competition Model, suggest that individuals process sentences based on the characteristics of the language (Bates & MacWhinney, 1989). Hence, individuals interpret the meaning of sentences by taking into account various competing linguistic cues that are contained in a sentence (e.g., word order, morphology, and animacy) and they will select the cue that is most likely to yield a correct interpretation of the sentence in their given language. Since, languages differ in the salience of specific linguistic cues that speakers use in sentence processing, cross-linguistic differences exist in individuals’ processing of sentences. For example, in English, word order is an essential cue (MacWhinney, 1997), while in Spanish, a highly inflected language, noun-verb morphology agreement is a stronger cue. Thus, the Competition Model argues that cross-linguistic differences will exist in sentence processing because languages emphasize different cues to convey meaning.
In 1997, MacWhinney redefined his competition theory to account for second-language learners; the result was the Unified Competition Model. The Unified Competition Model is distinct from the original Competition Model, as it was developed specifically to account for how individuals who are bilingual process sentences. According to the Unified Competition Model, learning multiple languages requires individuals to learn the cues that are important to each of the languages spoken. It claims that, initially, second-language learners will apply the linguistic cues (e.g., phonological, syntactic, lexical) that are important in their L1 when processing sentences in their L2. If individuals’ L1 and L2 are similar, like in Spanish and Italian, the cues that they transfer from their L1 when processing their L2 will be similar resulting in more instances of positive transfer (facilitates processing) (MacWhinney, 1997). However, in individuals’ whose L1 and L2 are very different, like Spanish and Chinese, the cues that individuals transfer from their L1 may not apply to their L2. This results in more instances of negative transfer (transfer that results in errors). Thus, at first, there might be a significant interconnection between individuals’ L1 and L2 processing (MacWhinney, 1997). However, as individuals acquire more experience with their L2, the level of language transfer reduces. As a result, individuals are more apt to construct a “firewall” that blocks L1 to L2 transfer, which then strengthens intra-language connections.

One of the most important components of the Unified Competition Model is the concept of language dominance (MacWhinney, 1997). Language dominance refers to a bilingual speaker’s most proficient language (Yip & Matthews, 2006). Paradis and Nicoladis (2007) suggest that bilingual individuals will often be more proficient in the language in which their knowledge is more advanced. In addition, they suggest that
people who are bilingual are usually more proficient in the language in which they have more exposure. However, language dominance is not static, and it is possible that bilingual individuals’ language dominance will change over time based on individual experiences (Fernandez, 2002). As a result, individuals who are bilingual may not always be dominant in their L1.

**Research studies supporting the effects of language dominance in the processing of sentences by bilingual speakers.** According to the Unified Competition Model (MacWhinney, 1997), individuals will process language more accurately in their dominant language. Balanced bilingual speakers (i.e., those with relatively equal dominance between languages) have the capacity to maintain strong within-language connections that prevent L1-L2 interference. Even so, these individuals retain between-language connectors that facilitate the ability to transfer information from one language to the other. Figure 1 below provides an example of L1 to L2 syntactic transfer, in which an L1-Spanish speaker wrote “Employee wash before back to returning work…” in her L2-English. While the sentence is ungrammatical in English, the sentence follows a syntactic structure that is consistent with Spanish. This sentence is an example of how it is highly plausible that initially, there might be transfer between a person’s L1 and L2, when he/she uses the cues of their L1 to process information in their L2. Thus, the cues that a bilingual speaker uses to process sentences depend on a range of factors, including age of acquisition, proficiency of L1 and L2, and language dominance (MacWhinney, 1997).
Another important aspect of the Unified Competition Model is that it suggests that although there is some level of separation between L1 and L2, the linguistic system of the bilingual individual remains unified as cognitive resources are shared (MacWhinney, 1997). For instance, bilingual individuals will have one mental model (or concept) of what a turtle is, yet they may have words for turtle in separate L1 and L2 lexicons (Hernandez, Li, & MacWhinney, 2005) (see Figure 2). In general, bilingual individuals share cognitive resources in both of their languages, even though they may have separate linguistic representations in their L1 and L2.
Figure 2. Bilingual speakers’ shared mental representations and separate lexicons

One way to examine theories of language processing, such as the Unified Competition Model (MacWhinney, 1997), is by investigating how individuals process sentences. Bilingual research conducted on the Unified Competition Model supports that bilingual adults may transfer sentence processing strategies from their L1 to their L2 as a result of language dominance (Fernandez, 2002; Hernandez, Bates, & Avila, 1994). In addition, this research indicates that the linguistic cues used by bilingual participants when processing sentences are language-dependent. For instance, the weight of three linguistic cues (word order, noun-verb morphology agreement, and animacy) in sentence processing was studied in two groups of monolinguals (Spanish and English) compared to Spanish-English bilinguals (Hernandez et al., 1994). The order of cue preference for the monolinguals was:
Hernandez and colleagues predicted that the Spanish-English bilingual speakers would process linguistic input in the same manner as monolinguals in that language. In other words, they predicted that individuals who were bilinguals would use the Spanish cue ranking (1) when processing Spanish sentences, and the English cue ranking (2) when processing English sentences. However, they found that the Spanish-English bilingual adults showed a greater preference for noun-verb morphology agreement and less attention to animacy cues in Spanish and English. These results were interpreted as an example of amalgamation, in which the bilinguals used the same strategy to process sentences in their L1 and L2 by merging the two cue hierarchies used by monolinguals in each language (Hernandez et al., 1994, p. 440).

Other studies conducted with Spanish-English bilingual adults (Dussias, 2004; Dussias & Sagarra, 2007; Fernandez, 2002; Vasilyeva, Waterfall, Gámez, Gómez, Bowers, & Shimpi, 2010) have also provided support for the Competition Model. For example, Dussias (2004) wanted to determine if proficient L1 Spanish-L2 English bilingual adults applied the same strategies as Spanish monolingual speakers when reading temporarily ambiguous Spanish sentences containing a complex noun phrase followed by a relative clause, such as *Peter fell in love with the daughter of the psychologist who studied in California*. In this study, all of the L1 Spanish-L2 English
adults resided in their L2 environment at the time the study was completed. In addition, they reported speaking Spanish and English daily in a variety of contexts and had been speaking English for an average of 3.7 years. They also noted that the texts they read in English were more diversified (e.g., literary works, magazines, textbooks, research journals) than the texts they read in Spanish (e.g., magazines, newspapers).

Consistent with previous findings, the monolingual English speakers showed preference for low-attachment (attaching the relative clause to the second noun phrase (N2) in the main clause), while the monolingual Spanish speakers showed preference for high-attachment (attaching the relative clause to the first noun phrase (N1) of the main clause) (Dussias, 2004). Like their English counterparts, the L1 English-L2 Spanish speakers also showed preference for low-attachment. However, the L1 Spanish-L2 English speakers did not show the same preference as Spanish monolinguals. They showed preference for low-attachment, like the English-speaking monolinguals.

One possible explanation for these results (Dussias, 2004) is that, as the bilingual L1 Spanish speakers gained more exposure in English (L2), there was a shift in their attachment preferences. The reason for this shift may be due to a change in language dominance. For instance, if individuals’ dominant language becomes their L2, it is possible that they will have difficulty accessing and integrating information in their L1. Hence, they will use the strategies of their dominant language (L2) when processing particular syntactic elements in their less dominant language (L1).

Fernandez (2002) also found that relative clause processing was related to bilingual adults’ language dominance. In this experiment, Spanish-English bilingual adults completed a language use questionnaire to determine language dominance. Based
on how the participants responded, they were placed in the English-dominant or Spanish-dominant group. The majority of the participants had learned Spanish first, and English second. In addition, most of the members of the English-dominant group had received the bulk of their schooling in the U.S. On the other hand, members of the Spanish-dominant group had more mixed language backgrounds, and had some of their early schooling outside the US. Finally, for both groups, the L2 was more often learned early in life (~10.5 years of age) with only a fraction of bilingual individuals learning their L2 later in life (overall, 15%).

Fernandez (2002) used an off-line measure (a questionnaire) in one experiment and an on-line (a self-paced reading questionnaire) in another. For both experiments, sentences were constructed with relative clauses that were attached high (to the N1) or low (to the N2). Furthermore, the sentences were manipulated for length (short or long) and number between the first and second noun (singular and plural). Examples of the sentences used were:

Andrew had dinner yesterday with the nephew of the teacher…(Singular N1, N2)

a. that was divorced. (Short)

b. that was in the communist party. (Long)

The journalist interviewed the daughters of the hostages…(Plural N1, N2)

a. that were waiting. (Short)

b. that were about to exit the airplane. (Long)
Fernandez (2002) found that the Spanish-English bilinguals attached the relative clause using the strategies of their dominant language. The bilingual speakers that were English-dominant showed preference for low-attachment in both of their languages, while the Spanish-dominant participants showed preference for high-attachment in Spanish and in English. These results further support that language dominance, and not order of language acquisition, plays an important role in how bilinguals will process sentences in their L1 and L2. Similar results have been reported for English-German bilingual adults (Jackson & Dussias, 2009).

**Research studies that have not supported the idea that L2 speakers process sentences as native speakers.** While Fernandez (2002) suggested that highly proficient L2 speakers adopt the same parsing strategies as native speakers, Papadopoulou and Clahsen (2003) found contradictory results. These researchers studied how Spanish, German, and Russian L2 adult speakers of Greek processed relative clauses when reading Greek equivalents of sentences, such as *A man called the student (masculine) of the teacher (feminine) who was disappointed (masculine) by the new educational system.*

The L2-Greek speakers had been residing in Greece for an average of 9.7 years; however, they had only been receiving formal instruction in Greek for an average of 1.9 years. In addition, they were first exposed to Greek when they were approximately 24 years old. Furthermore, all of the L2 Greek speakers demonstrated high Greek proficiency as indicated by a formal assessment.

Papadopoulou and Clehsen (2003) found that although native speakers of Greek preferred to attach the relative clause to the first noun phrase (a man), the L2 speakers of Greek did not show any consistent preferences for either NP1 or NP2 attachment. These
researchers suggested that the native speakers might have attached the incoming lexical information to the first noun phrase after immediately reading the sentence containing the relative clause. However, L2 speakers may delay attachment of the relative clause until they have received sufficient lexical or syntactic information, making their processing of relative clauses distinct from their monolingual counterparts, at least while reading. These differences in processing by L2 and native speakers may result from their difficulty integrating different sources of information when processing their L2. In addition, the results from this study suggest that even if individuals demonstrate high L2 proficiency, they may not apply the same strategies as native speakers when processing relative clauses.

**Summary.** Although some models of bilingual language processing suggest that language dominance plays a role on how individuals will comprehend complex sentences (MacWhinney, 1997), to date, research on bilingual sentence processing has led to contradictory findings (Dussias, 2004; Fernandez, 2002; Hernandez et al., 1994; Papadopoulou and Clahsen, 2003). On one hand, there is research supporting that L2 speakers will process sentences in the same way as monolingual speakers (Dussias, 2004; Fernandez, 2002), while there is also research supporting that L2 speakers do not process sentences in the same way as native speakers (Papadopoulou and Clahsen, 2003).

In addition, research on bilingual sentence processing has investigated if factors such as word order, animacy, and noun-verb morphology agreement are involved in the comprehension of complex syntax, but to date, these results have been inconclusive (Dussias, 2004; Fernandez, 2002; Hernandez et al., 1994; Papadopoulou and Clahsen, 2003). Thus, it is important to investigate other factors that may possibly be involved in
sentence processing. A common way of investigating language processing is by investigating how individuals comprehend complex sentences containing relative clauses (MacWhinney & Pleh; 1988; Weighall & Altmann, 2010). Given that bilingual individuals’ processing of relative clauses has been limited to date, it is important to investigate the research on monolingual speakers’ processing of relative clauses.

Relative Clause Processing by Monolingual Speakers

To date, research conducted on monolingual speakers’ processing of relative clauses has found that aspects of syntax, such as word order (Cuetos & Mitchell, 1988), memory load (Weighall & Altmann, 2010), and animacy (Mak et al., 2006), lead to difficulties in the comprehension of complex sentences in both adults and children. One of the major controversies when studying how monolingual individuals’ process relative clauses is which type of relative clause is most difficult to process (subject or object-modifying relative clauses). Some researchers suggest that the relative clauses that are most difficult to process are universal across languages (De Vincenzi & Job, 1993); while others suggest that the difficulty imposed by relative clauses is language-dependent (Gutierrez-Mangado, 2011; Mak et al., 2006).

For example, Felser and colleagues (2003) investigated the role of memory capacity on preferences for relative clause attachment in monolingual English-speaking children (6-7 years old) during a self-paced reading task. Their results indicated that children processed relative clauses differently based on listening span. The children with a high-listening span showed preference for attaching the relative clause to the first noun phrase, because they could hold the information they encountered at the beginning of the
sentence in their working memory until the relative clause was reached. On the other hand, the children with a low-listening span attached the relative clause to the second noun, because they did not have the memory capacity to hold the information they processed at the beginning of the sentence.

Weighall and Altmann (2010), however, found divergent results. These investigators also administered a listening-attention span to classify children (ages 6-8) into high and low attention groups. They found that both groups of children had better comprehension of subject-modifying relative clauses (e.g., *The cat that bumped the bear will hug the cow*) than of object-modifying relative clauses (e.g., *The cow will hug the cat that bumped the bear*). Hence, both groups of children had difficulty with object-modifying relative clauses, which suggests that factors other than difficulties in working memory capacity may be operational.

Studies investigating the role of word order have also led to contradictory results. For example, De Vincenzi and Job (1993) examined the processing of relative clauses by monolingual Italian-speaking adults. These researchers found that although English and Italian differ in that English has a strict word order, both groups of individuals showed a preference for low attachment (where the relative clause is attached to the second noun phrase-NP2). These researchers explained that attaching the relative clause to NP2 is easier as it reduces memory load.

On the other hand, Cuetos and Michell (1988) found that Spanish-speaking monolingual adults showed a preference for attaching the relative clause to the first noun, or the subject, of the main clause. They attributed this discrepancy to the differences in
where the adjectives are placed in Spanish versus English sentences. For instance, in English, the adjective precedes the noun (i.e., The black cat), but in Spanish, adjectives follow the noun (i.e., El gato negro [The cat black]). In addition, word order in Spanish is more flexible, and sentences are usually constructed so that the most important feature is stated first. Thus, the following construction is permissible in Spanish: Noun Phrase (NP)-Adjective (Adj)-Relative Clause (RC), like in the sentence, El gato (NP) negro (Adj) que bebió leche (RC) se trepó a un árbol [The black cat that drinked milk climbed a tree]. These investigators argue that because the latter construction is more frequent in Spanish, monolingual speakers are more apt to link the relative clause to the subject of the main clause. These findings suggest that relative clause attachment preferences may be influenced by the characteristics of the language.

Gutierrez-Mangado (2011) argues that relative clauses that are easier to comprehend are language-dependent. In this study, Basque-speaking children’s (ages four–six years old) comprehension of subject and object-modifying relative clauses was investigated. Basque is an Ergative language, meaning that the subject of the intransitive verb and the object of the transitive verb are considered to be the same case, and are marked similarly. For example, in the sentence, The lady opened the door, the word lady would be nominative in English, while word door would be accusative; however, in Basque, both nouns would be considered to be nominative.

In addition, relative clauses in Basque differ from those in English and Spanish because they do not contain a wh-element heading the relative clause and the head of the relative clause comes right after the relative clause, like in Chinese and Japanese, but unlike in English (Gutierrez-Mangado, 2011). Comprehension of relative clauses in
children was studied using a binary-picture matching task, in which the children had to point to the picture that corresponded to the relative clause that was read by the investigator, such as *The grandmother who is kissing the girl* (subject-modifying) and *The grandmother who the girl is kissing* (object-modifying). The findings from this study revealed that the children had better comprehension of object-modifying relative clauses. One possible explanation for these results is that in Basque, the relative clauses are constructed in a way distinctively different from Indo-European languages (e.g., Spanish, English. For instance, in Basque the head of the relative clause precedes the relative clause. The findings obtained by Gutierrez-Mangado suggest that the characteristics of a language influence which type of relative clause (subject or object-modifying relative clause) is easier to comprehend.

In summary, the research findings on relative clause processing appear to be contradictory. For instance, when word order is tested, object-modifying relative clauses are preferred in Italian and Basque (De Vincenzi & Job, 1993), while subject-modifying relative clauses are preferred in Spanish (Cuetos & Mitchell, 1988). Given these contradictory results, future research conducted on relative clause processing should control for linguistic factors known to influence relative clause processing (i.e., word order, animacy, memory load), while investigating other possible factors that may be related to difficulties in relative clause processing.

Another factor that may influence syntax processing is perspective shifting (MacWhinney, 2005). MacWhinney’s proposed that theory of mind and syntax play a role in the comprehension of complex sentences. The Perspective Hypothesis is described in detail in the section below.
**Perspective Hypothesis**

Perspective taking refers to one’s ability to see another’s point of view. According to MacWhinney (2005), perspective taking is at the core of children’s higher cognitive development. In his Perspective Hypothesis, MacWhinney proposes that children begin to track perspective shifts in a language by learning the cognitive pathways and mental models supported by their culture. He believes that a child’s development of these cognitive and mental models provides a foundation for sentence processing, grammatical constructions, language acquisition, and the co-evolution of language and cognition.

Given the important role of perspective taking and shifting in language, MacWhinney (2005) designates grammatical constructions whose specific role is to mark changes in perspective. He suggests, for instance, that when individuals process grammatical constructions that specifically mark shifts in perspective, they integrate information by creating images derived from one, or a combination of, the following five systems: *direct experience, space/time deixis, events, social roles, and mental acts*.

Individuals apply their direct experience when they encounter words with which they have personally interacted (MacWhinney, 2005). For example, when perceiving the word “banana,” one envisions the smell, texture, and taste of that fruit because one has direct experience with a banana. Deixis refers to a word or phrase that requires contextual information in order to be understood (e.g., in English the adverb, *there*, like in the sentence, *He is sitting over there*). Space and time deixis requires an individual to first assume the position of another person and then make spatial and temporal judgments based on the position/time deixis of the other person. For example, in the sentence, *Mary
is in front of the house and Bob is behind the house, the spatial perspective of an individual will shift based on whose perspective one is taking (Mary’s or Bob’s), as well as the relative relationship in space of Mary or Bob to the speaker.

Perspective taking of events also requires that a person maintain an overall causal effect across a series of individual events (MacWhinney, 2005). For example, when reading a sentence on how to make bread, such as, *Start by making the dough by mixing flour, salt, and baking soda; place the dough in the oven after letting it rise in room temperature*, one needs to shift perspectives. In the first part of the sentence, one takes the perspective of the person making the dough. For the second section, there is a shift and one takes the perspective of the actual dough. Although the sentence above appears to have a relatively simple grammatical construction, it requires two shifts in perspective.

Many grammatical structures also elicit social knowledge (MacWhinney, 2005). For instance, an individual’s perspective of the social status of another will be different if one addresses him or her as *your Honor*, or *you*. Similarly, the use of mental state verbs, such as *want*, *apologize*, or *forgive*, requires coordination of perspective taking. For example, in the sentence, *John admired Mary, because she was calm under stress* (MacWhinney, 2005, p. 219), the word *admired* elicits a shift in perspective from John to Mary because the word *admired* is used to describe one’s feelings for another individual. Hence, the grammatical structure of the sentence facilitates perspective shifting. As can be seen, the Perspective Hypothesis (MacWhinney, 2005) suggests that there are connections between perspective taking and how syntax is understood and produced. Moreover, this hypothesis emphasizes the importance of theory of mind in the processing of complex syntax.
Theory of mind. Over the years, children develop two levels of theory of mind. First-order theory of mind is defined as an individual’s ability to think about another individual’s thoughts about an external event (Silliman, Diehl, Bahr, Hnath-Chilsom, Zenko, & Friedman, 2003). When children are initially developing first-order theory of mind, they are going through a developmental phase in which they come to understand that people’s beliefs are connected to their actions. For example, when hearing a sentence such as, *Mary wants ice cream because she is hungry*, a child who has first-order theory of mind will infer that Mary’s desire (noted by the mental state verb *want*) will lead her to an action (eating ice cream). A second and more complex type of theory of mind is second-order (Silliman et al., 2003), which requires that children consider what others think in regard to other people. This type of theory of mind necessitates that children coordinate multiple perspectives about what two other individuals are thinking in cases where the characters’ beliefs conflict, but only the child knows it (Silliman et al., 2003). Thus, second-order theory of mind is a complex skill requiring the understanding and management of different perspectives at the same time.

Research has indicated that, as children’s theory of mind develops, their ability to produce relative clauses improves (Perez-Leroux, 1998). This research suggests that theory of mind and relative clauses may be related. Specifically, she examined whether the production of the subjunctive mood relative clause was related to young children’s (ages 3 to 6 years) capacity to understand false beliefs. Subjunctive mood relative clauses are used to express one’s emotional opinions or beliefs about another person’s actions or experiences. In English, the subjunctive mood is rarely used; however, in the example *If I were a rich man, I wouldn’t want to work hard*, the subjunctive mood is indicated by the
verb, *were*. In this study, Perez-Leroux assessed the production of subjunctive relative clauses with a relative clause elicitation task. Children were presented with pictures containing several characters that only differed by one quality and read a series of stories. In each of the stories, one of the characters was looking for particular qualities in a helper. Children were then asked to identify which of the other characters could help. The questions were asked in such a way that use of a subjunctive relative clause was obligatory in order to answer correctly. Results indicated that there was a significant correlation between the children’s production of the subjunctive relative clause and their performance on false-belief tasks. These findings indicated that there was a strong association between theory of mind and the ability to produce and understand complex relative clauses. These results provide support for the Perspective Hypothesis (MacWhinney, 2005), which states that relative clauses leading to comprehension difficulties are those requiring multiple shifts in perspective.

**Perspective shifting in relative clauses.** One of the primary assumptions made by MacWhinney’s (2005) Perspective Hypothesis is that individuals must shift perspectives in order to comprehend complex syntax. MacWhinney states that relative clauses are an example of complex sentences that require multiple shifts in processing perspective. As examples of perspective shifting, MacWhinney provides a continuum of complexity with four types of restrictive relative clauses:

- SS: The dog that chased the cat kicked the horse. 0 switches
- OS: The dog chased the cat that kicked the horse. 1- switch
- OO: The dog chased the cat the horse kicked. 1+ switch
- SO: The dog the cat chased kicked the horse. 2 switches
These restrictive relative clauses either have a subject or object as the head of the main clause and the relative clause defines either the subject or the object of the sentence (MacWhinney & Pleh, 1988). The first letter abbreviation, either “S” or “O”, explains the role of the first noun in the main clause. The second letter abbreviation indicates the function of the first noun encountered in the relative clause. The SS and SO types are considered to be subject-modifying relative clauses because they modify the subject of the main clause. The OS and OO relative clauses are object-modifying relative clauses and they modify the object of the main clause. In sum, MacWhinney (2005) proposed that the complexity of each type of restrictive relative clause was related to the number of perspective shifts that each required:

(1) **Subject-subject (SS) perspective.** The SS relative clause is considered to have 0 shifts in perspectives, because the perspective of the main clause is that of the relative clause. Thus, there are no true changes in perspective. According to MacWhinney, the zero switch relative clause is the easiest to process.

(2) **Object-subject (OS) perspective.** The OS relative clause is described as having 1 minus (1-) shifts in perspectives because the perspective shifts from the main clause subject to the main clause object. This 1- switch is less abrupt because the main clause object has already received some attention before the switch is made.

(3) **Object-object (OO) perspective.** The OO perspective is described as having a 1 plus (1+) switch. In the OO relative clause, the shift is even more abrupt, as the perspective shifts to the subject of the relative clause.
(4) *Subject-object (SO) perspective.* The SO relative clause is defined as having 2 switches, because there is a double change in perspective. The perspective is initially that of the main clause subject. Then, it switches to that of the main clause object, only to shift back again to the main clause subject when the second verb is encountered. Given the complexity of this shift, MacWhinney (2005) theorizes that the 2 switch type is the most difficult type of switch to process.

Based on this description, the perspective account predicts this order of difficulty:

SS > OS = OO > SO.

*Direct investigations of perspective shifting.* The complexity of these shifts was directly investigated by MacWhinney and Pleh (1988) in Hungarian. This study involved 20 monolingual, Hungarian-speaking adults who participated in a self-paced reading task (an online measure of syntax processing). Each sentence was accompanied by a comprehension question that asked the participant to identify the head noun of the relative clause. For example, in a sentence like *The bear that the eagle pushed chased the lion,* the participant was asked *Who did the eagle push?*

The findings from this study supported the Perspective Taking Hypothesis, since the Hungarian speakers in this study had the most difficulty in sentences that required them to take multiple shifts in perspective (MacWhinney, 2005). For sentences following the SVO word order, the results were consistent with English (MacWhinney, 1982) and French (Sheldon, 1977), in which the least to most difficult perspective shifting sentence types were: SS > OS = OO > SO. According to MacWhinney and Pleh (1988), these findings suggest that perspective maintenance highlights general cognitive, rather than
language-specific, processes. For instance, although French and English have different word order preferences (Sheldon, 1977), studies revealed that in both languages, participants had the same difficulties with perspective shifting sentences. Hence, cognitive processing (i.e., manipulating multiple shifts in perspectives), and not language-specific syntax, lead to difficulties in sentence processing.

In recent years, the role of perspective shifting in the processing of relative clauses has also been investigated directly (Jones, 2010; Wilkinson et al., 2008). For instance, Jones examined MacWhinney’s (2005) Perspective Hypothesis in English-speaking monolingual adults by gathering response time (RT) data. Jones predicted that, consistent with the Perspective Hypothesis, easier shifts in perspective would yield faster response times due to reduced processing required for less complex shifts in perspectives. However, the results from this study did not support the predictions since the OO (1+ condition) sentences led to faster RTs. Jones explained that the 1+ switch condition (e.g., *The clown washed the elephant [that the boy painted]*) was the easiest to process because individuals processed the first clause (*The clown washed the elephant*) independently from the second clause (*that the boy pointed*). According to Jones, processing the two clauses independently possibly allowed for processing at the local level. Hence, Jones concluded that perspective shifting alone does not lead to difficulties in processing, and local syntactic constructions facilitate relative clause processing.

Wilkinson et al. (2008) presented on a preliminary study that directly investigated the role of perspective shifting in Spanish-English bilingual children’s processing of relative clauses in both of their languages. In this preliminary study, children had to determine whether the sentence they heard orally matched the picture they saw on a
computer screen. The participants’ performance on this experimental task was evaluated with percent correct data. The findings from this study revealed that the SS (0 switch) and OO (1+ condition) sentences were easier to process than the SO (2 switch conditions). There was no significant differences noted in accuracy for the 1- (OS) condition. These patterns were evident in both Spanish and English. Since the results did suggest that the 2 switch condition was the most difficult to process, these investigators concluded that the participants had difficulty tracking the shifts in perspective in the sentences. However, results for the other sentence types did not follow MacWhinney’s (2005) proposed hierarchy. Nevertheless, these results should be interpreted with caution due to the small sample size.

In sum, only three studies have directly investigated the role of perspective shifting in relative clause processing (Jones, 2010; MacWhinney & Pleh, 1988; Wilkinson et al., 2008), but only one study (Wilkinson et al., 2008) focused on children. Findings are therefore difficult to compare given that they differed significantly in methodologies, languages assessed (Hungarian versus English), and, most significantly, in participant ages (adults versus children).

Indirect studies of perspective shifting. Studies that have directly examined the role of perspective shifting in the processing of relative clauses are limited (Jones, 2010; MacWhinney & Pleh, 1988; Wilkinson et al., 2008); however, a few investigations have indirectly studied perspective shifting in relative clauses (Hsiao & Gibson, 2003; Smyth, 1995). For example, Smyth (1995) examined English-speaking children’s (ages 5-8 years old) conceptual perspective-taking with respect to their cognitive development. More specifically, he investigated the Revised Experiencer Constraint (REC) hypothesis, which
claimed that individuals will be less likely to attach relative clauses to the object of the main clause if the relative clause provides information that should already be known by the addressee in the sentence. For example, in a sentence like “Bill told Harry that Sue bored him” the speaker is less likely to attach the relative clause to the object of the main clause (i.e., Harry) because Harry should already know the information that is provided by the relative clause (i.e., that Sue bores him). On the other hand, subject-modifying relative clauses, such as “Bill told Harry that he liked Sue,” provide additional information about the subject of the main clause, so a listener is likely to be biased towards attaching the relative clause to the subject of the main clause. In other words, the REC hypothesis states that listeners are more likely to attach the relative clause to the noun in the main clause (subject or object) that will receive more information.

In order to attach the relative clause to either noun in the main clause, the REC hypothesis claims that listeners need to be efficient at perspective taking (Smyth, 1995). In order for listeners to correctly interpret object-modifying relative clauses (which may not seem to add new information to the main clause), listeners must create a mental representation of the speech act. This mental representation allows listeners to shift from their own perspective to that of the speaker, and then infer from that perspective what the addressee already knows. According to the REC hypothesis, if a child has limited perspective taking capabilities, this may affect his or her ability to accurately interpret the meaning of the relative clause sentences.

In Smyth’s (1995) study, a puppet and verbal task were administered to examine the relationship between the REC hypothesis and perspective taking. Two types of sentences were presented to each child. The first type of sentence contained relative
clauses biased towards the subject of the main clause (i.e., *Mickey told Barney that he liked Wonder Woman*). The second type of sentence was neutral, and the relative clause could be attached to either the subject or the object of the relative clause (i.e., *Mickey told Barney that Wonder Woman liked him*). The results from this study indicated that children had less difficulty with accurately shifting perspectives as they got older. Although the younger children in the study also shifted perspectives adequately, their processing of these perspective shifts was not as spontaneous as the shifts in previous studies with adults (Smyth, 1995). Since the children in the study shifted perspectives adequately, but not as quickly as adults, these findings suggested that cognition may play a role in the ability to quickly and effectively process complex sentences.

In sum, MacWhinney’s (2005) Perspective Hypothesis proposes that the comprehension of complex syntax is a cognitive process in which individuals must be able to switch perspectives adequately. To date, research on sentence processing has focused primarily on adults in terms of the roles played by word order (Cuetos & Mitchell, 1998), memory capacity (Domenico & Matteo, 2009), and animacy (Betancort, Carreiras, & Sturt, 2009); yet, results have been inconclusive. MacWhinney (2005) provides another possible factor that may be involved in sentence processing. He theorizes that aside from factors such as word order and memory capacity, perspective shifting (a cognitive process) plays a role in the comprehension of complex relative clauses. Since cognitive processing has not been as studied as widely in either the adult or child sentence processing research, much less the bilingual child research literature, MacWhinney’s Perspective Hypothesis warrants further examination. More specifically, the role of perspective shifting in individuals who are bilingual has only been examined
by one preliminary study (Wilkinson et al., 2008). Investigating the role of perspective shifting in the processing of relative clauses by bilingual speakers may help add to the knowledge on possible factors that affect how child speakers who are bilingual will comprehend relative clauses in their L1 and L2.

**Statement of the Problem**

As illustrated by the review of the research available on adults’ processing of relative clauses, three factors, including word order (Cuetos & Mitchell, 1988), memory capacity (Domenico & Matteo, 2009), and animacy (Betancort et al., 2009), have been associated with the comprehension of relative clauses. Nevertheless, the research completed to date on bilingual and monolingual speakers has led to contradictory results. MacWhinney’s (2005) Perspective Hypothesis brings attention to another possible factor in the processing of syntax. He theorizes that at the heart of sentence comprehension is cognitive processing, involving perspective switching. To illustrate the relationship between cognition and perspective taking, MacWhinney states that there are four types of relative clauses (SS, OS, OO, SO) that require increasingly complex shifts in perspective. He theorizes that individuals will present with the most difficulty understanding relative clauses that contain the most complex perspective shifts.

Although MacWhinney (2005) notes four type of perspective shifting relative clauses, the majority of the current research conducted on sentence processing has focused on only two types of relative clauses: subject modifying relative clauses (SS) and object-modifying relative clauses (OO) (Betancort et al., 2009; Cuetos & Mitchell, 1988; Domenico & Matteo, 2009; Frazier & Rayner, 1982). Thus, previous research may have resulted in an incomplete view of the factors involved in relative clause processing.
Examining relative clause processing using the four types of relative clauses proposed by MacWhinney has the potential benefit of providing researchers and speech-language pathologists with a more complete view of the multidimensional factors involved in bilingual sentence comprehension. Additionally, completing within-subject, cross-linguistic comparisons of bilingual relative clause processing would allow for the comparison of cross-linguistic differences while avoiding some of the difficulties present when comparing two different, monolingual groups across studies.

The aim of the current study is to add to the current body of literature on bilingual relative clause processing by examining the effects of perspective shifting in the processing of relative clauses in Spanish and English by bilingual (Spanish-English) children. Language processing will be studied by comparing levels of accuracy and response time while processing four kinds of relative clauses in their L1 versus L2. Higher levels of accuracy and faster response time have suggested ease of processing (De Vincenzi & Job, 1993; MacWhinney & Pleh, 1988; Mak et al., 2006). The information gathered from completing this study could potentially add to an overall understanding of how bilinguals orally process sentences.

**Predictions**

The Perspective Hypothesis (MacWhinney, 2005) proposes that sentences containing relative clauses requiring multiple shifts in perspective are more difficult to comprehend than those containing one or no perspective shifts. In order to isolate the potential role of perspective shifting on sentence comprehension, the stimuli will be controlled in Spanish and English for other factors associated with relative clause processing, such as word order (Cuetos & Mitchell, 1988), memory load (Domenico &
Matteo, 2009), and animacy (Betancort et al., 2009). This type of stimuli will allow for cross-language comparisons of complex sentence processing. Since the sentences will control critical factors previously noted in the research on relative clause processing, the order of difficulty imposed by increasingly complex perspective shifts should be similar in Spanish and English. Based on MacWhinney (2005), the two specific predictions for level of accuracy and level of difficulty are the following:

1. The easier the perspective shift, the higher the level of accuracy; thus, the perspective shift relative clause sentences will yield the following order of difficulty: SS (0 switch) > OS (1-) = OO (1+) > SO (2 switch) in Spanish and English for the bilingual speakers, and in English for the monolingual speakers.

2. Level of difficulty will be associated with longer response times (RTs). Therefore, RT SS (0 switch) < RT OS (1-) = RT OO (1+) < RT SO (2 switch)
Chapter 2

Methods

Participants

A total of 16 Spanish-English bilingual children (10 females, 6 males, $M_{age} = 9.5$ years, SD=1.23) and 13 monolingual English-speaking children (7 females, 6 males, $M_{age} = 9.4$ years, SD=1.26), who were enrolled in grades 3 and 5, participated in this study (see Appendix A for detailed description of participants’ demographic information). Inclusion criteria to participate in the study included the following:

1. Normal hearing as determined by a hearing screening. A GSI portable audiometer calibrated to ANSI 1996 standards was used to perform a pure-tone air conduction hearing screening test. Screening levels of 25 dBHL at 1000, 2000, and 4000 Hz were employed. All tones were presented bilaterally.
2. Normal or corrected-to-normal vision, as reported by parents or legal guardian.
3. No history of neurological injury or developmental delay affecting speech or language development, and/or hearing, as reported by parent or legal guardian.
4. Score within $\pm 3$ standard deviation (SD) of the mean ($M = 10$) on the Listening to Paragraphs and Concepts and Directions subtests from the Clinical Evaluation of Language Fundamentals-4 (CELF-4; Semel, Wiig, & Secord, 2003). Bilingual students also completed these subtests in Spanish on
the *Clinical Evaluation of Language Fundamentals-4: Spanish Edition* (CELF-4 Spanish; Semel, Wiig, & Secord, 2006).

5. At least 85% accuracy on a second-order false belief task, which included social inferencing of psychological states, as well as logical inferencing of physical states (Silliman et al., 2003). This test was presented only in English.

These participants were recruited from a public school, an after school program, and from graduate students at the University of South Florida, following approval from the Institutional Research Board at the University of South Florida and the school district. Parental or legal guardian consent and the participants’ verbal assent were required for participation. A description of the participants’ language screening and second order false belief task results are provided in detail below.

**Language screening results.** On the English and Spanish versions of the CELF-4, participants needed to obtain a score that was + 3 SD from the mean (M=10). In this study, all of the participants’ Spanish and English CELF-4 scores fell + 3 SD from the mean, except two third grade bilingual males, who scored a 5 on the Spanish edition of the Understanding Spoken Paragraphs subtest of the CELF-4. These participants were included in the study, because they demonstrated Spanish proficiency during an informal conversation with the investigator, who is a native Spanish speaker. Participants’ average scores on the language screenings administered are provided in Table 1 below (See Appendix B for a detailed account of each participant’s language screening scores). Finally, the participants completed the second order false belief task with an average of 88% or greater accuracy, indicating they were able to take the perspectives of others.
Table 1

Language Screening (English and Spanish) and Second-Order Theory of Mind Scores across Grade and Language Groups

<table>
<thead>
<tr>
<th>Participants</th>
<th>English CELF-4</th>
<th></th>
<th></th>
<th>Spanish CELF-4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Second-Order False Belief Task (%)</td>
<td>English Following Directions</td>
<td>Understanding Spoken Paragraphs</td>
<td>Following Directions</td>
<td>Understanding Spoken Paragraphs</td>
</tr>
<tr>
<td><strong>Third Grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilingual Female</td>
<td>88.6</td>
<td>7.29</td>
<td>9.6</td>
<td>8.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Bilingual Male</td>
<td>94</td>
<td>8.3</td>
<td>10</td>
<td>8</td>
<td>5.7</td>
</tr>
<tr>
<td>Monolingual Female</td>
<td>91</td>
<td>9.7</td>
<td>10.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monolingual Male</td>
<td>92.5</td>
<td>9.75</td>
<td>12.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Fifth Grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilingual Female</td>
<td>93.25</td>
<td>7.75</td>
<td>8.75</td>
<td>10.25</td>
<td>8.25</td>
</tr>
<tr>
<td>Bilingual Male</td>
<td>88.3</td>
<td>9</td>
<td>10.7</td>
<td>11</td>
<td>9.7</td>
</tr>
<tr>
<td>Monolingual Female</td>
<td>96.7</td>
<td>8</td>
<td>11.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monolingual Male</td>
<td>97.3</td>
<td>11.3</td>
<td>11</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note.* CELF-4 English and Spanish Mean = 10; SD ±3

In order to obtain a better picture of the bilingual participants’ language abilities, information regarding the languages spoken by the participants was obtained using a language use questionnaire (see materials section for more details). The language use questionnaire was used to gather data on the bilingual participants’ language use at home and school, country of origin, education obtained outside of the United States, etc. (see Table 2 below for a summary of the data compiled).
Table 2

*Bilingual Participant Language Questionnaire Results (N=16)*

<table>
<thead>
<tr>
<th>Country of Origin</th>
<th>Language(s) Spoken at Home</th>
<th>Time English Learned</th>
<th>Time English Spoken</th>
<th>Time Spanish Spoken</th>
<th>Language Considered Stronger</th>
<th>Number of Participants that Attended School Outside the U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Mexico</td>
<td>11 Spanish</td>
<td>13</td>
<td>After Spanish</td>
<td>Mean = 7.4 years</td>
<td>1 Spanish</td>
<td>7 English</td>
</tr>
<tr>
<td>4 Puerto Rico</td>
<td>5 Spanish and English</td>
<td>1</td>
<td>Before Spanish</td>
<td>Mean = 3.9 years</td>
<td>1 Spanish</td>
<td>4 out of 16 participants</td>
</tr>
<tr>
<td>1 Cuba</td>
<td></td>
<td>2</td>
<td>Simultaneous</td>
<td></td>
<td>8</td>
<td>Both</td>
</tr>
</tbody>
</table>

As illustrated by Table 2, the majority of the bilingual participants reported speaking primarily Spanish at home. Also, the majority of the participants reported learning English after learning Spanish. On average, the participants had been speaking Spanish longer than English; however, only one of the 16 participants considered Spanish to be his or her more dominant language.

**Materials**

**Sentences and switch types** A total of 100 sentences were constructed (50 in English and 50 in Spanish) to assess children’s processing of relative clauses containing increasingly complex shifts in perspective, based on MacWhinney’s (2005) perspective shifting model. Ten sets of sentences, each containing four types of perspective shifts and one control sentence, were constructed. The same sets of sentences were constructed in Spanish and in English. See Appendix C for an entire list of the sentences used in the experiment.
Four of the five sentences in each set contained relative clauses, each one containing a different type of perspective switch. The four types of perspective shifts included: SS (0 switch), OS (1- switch), OO (1 + switch), and SO (2 switch). Each perspective in shift contained increasingly complex syntax. A SS sentence (0 switch) is defined as such because there are no shifts in perspective. In the zero switch sentences, the perspective of the main clause is also the perspective of the relative clause. In an OS (1- switch) sentence, the perspective shifts from the main clause subject to the main clause object. This shift in perspective is less abrupt because some attention has already been paid to the object of the main clause. In an OO (1+ switch) sentence, the perspective shifts more abruptly to the subject of the relative clause. Finally, the most complex shift of perspective is the SO (2 switch) sentence where the initial perspective is that of the subject of the main clause. However, when the second noun is encountered, the perspective shifts to that of the object of the main clause. Finally, when the second verb is encountered, the perspective shifts once again to the original main clause subject (MacWhinney, 2005). Table 3 below shows examples of the four types of perspective shifting sentences.
Table 3

Examples of Perspective Shifting Sentences (NP1 is in bold, and the targeted verb is underlined)

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Switch Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>0 switch</td>
<td>The <strong>boy</strong> that touched the grandfather <strong>kicked</strong> the man.</td>
</tr>
<tr>
<td>OS</td>
<td>1 minus</td>
<td>The grandfather touched the <strong>boy</strong> that <strong>kicked</strong> the man.</td>
</tr>
<tr>
<td>OO</td>
<td>1 plus</td>
<td>The man touched the grandfather that the <strong>boy</strong> <strong>kicked</strong>.</td>
</tr>
<tr>
<td>SO</td>
<td>2 switch</td>
<td>The <strong>boy</strong> that the grandfather touched <strong>kicked</strong> the man.</td>
</tr>
</tbody>
</table>

In each sentence set, the three nouns were selected for each switch type and these remained constant within the sentence set. The noun serving as the subject of the main clause varied depending on the type of switch. The word in bold corresponds to the noun that served as the subject of the main clause for the zero switch. This noun is bolded in all of the four switch types in order to demonstrate how the perspective of the noun changed with each switch type. The second verb is underlined in each switch type. The second verb in each sentence corresponded to the verb of the relative clause.

In developing the perspective shift sentences in Spanish, the effects of animacy were taken into consideration. According to Betancort et al. (2009), Spanish sentences are most ambiguous when all of the nouns are animate. Nouns or pronouns are categorized as animate based on how humanized or alive their referents are. Examples of animate nouns include people, animals, or things that have been given human qualities. In
Spanish, when nouns are preceded with the determiners *al* or *a la*, like in *a la gata* [the cat (female)], individuals receive a cue that the subsequent noun is animate. Thus, when Spanish readers read the determiners *al* or *a la*, they receive a cue as to the animacy of the proceeding noun. However, if Spanish readers read a sentence in which both the noun phrase and the internal noun of the relative clause are animate, this increases the difficulty of sentence processing because there are no syntactic cues easing the processing of the noun (e.g., *El niño que tocó al viejo pateó al hombre*.) Thus, in order to maintain the sentential ambiguity, animacy remained constant in the Spanish sentences. The nouns in the English sentences were also kept animate to maintain consistency between the Spanish and English sentences.

**Nouns.** A total of 10 nouns were selected using two criteria: word frequency and gender. The 10 nouns were distributed equally between two categories: 1) five female human nouns, and 2) five male human nouns. Word frequency was controlled when selecting the nouns in the sentences to insure that the words selected were familiar to the readers, and did not impose extraneous delays in sentence processing. Nouns were selected using *A Frequency Dictionary of Spanish: Core Vocabulary for Learners* (Davies, 2006). This dictionary contains a listing of the most frequently occurring 5,000 words in spoken and written Spanish, selected from a 20,000,000 word corpus. The corpus represents a wide array of registers and dialects. Two-thirds of the corpus comes from the written register, and one-third comes from spoken Spanish. Approximately one-half of the corpus (2,300,000 words) obtained from spoken Spanish comes from transcripts of natural speech from 11 different countries (not including the United States). The written corpus, which excluded the United States, was obtained from literary and
non-literary texts, including newspaper articles, essays, letters, and humanistic texts. Approximately 43% of the texts came from Spain, and 57% from Latin America. The selected nouns had a frequency range of 80 to 4305 per 5,000 words. The higher frequency boundary was expanded to include words that were constant through dialects. Table 4 depicts the selected nouns with their corresponding word frequencies per 5,000 words.

Table 4

<table>
<thead>
<tr>
<th>Nouns Selected for the Experimental Sentences with Corresponding Word Frequencies per 5,000 Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Nouns</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>mujer</strong> [woman]</td>
</tr>
<tr>
<td><strong>enfermera</strong> [nurse]</td>
</tr>
<tr>
<td><strong>niña</strong> [girl]</td>
</tr>
<tr>
<td><strong>reina</strong> [queen]</td>
</tr>
<tr>
<td><strong>bruja</strong> [witch]</td>
</tr>
</tbody>
</table>

Verbs. The verbs were selected according to the following two criteria: syllable length and word frequency. The Spanish verbs primarily contained two-syllables or three-syllables, because these are the most common syllable lengths in Spanish. A total of 10 target verbs were selected in the construction of the sentences described below.

Like the nouns, frequency criteria for the verbs were also selected using the Davies (2006) resource by applying the same procedure previously described for the nouns. The verbs selected were those whose frequency per 5,000 words was between 97
and 4078. The upper frequency boundary was much higher than that of the nouns because the words selected had to be action verbs (i.e., *kick*, rather than *love*, which is a mental verb). Table 5 lists the 10 verbs selected and their corresponding frequency per 5,000 words.

Table 5

<table>
<thead>
<tr>
<th>Verb</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>followed [persiguió]</td>
<td>97</td>
</tr>
<tr>
<td>carried [cargó]</td>
<td>289</td>
</tr>
<tr>
<td>covered [cubrió]</td>
<td>691</td>
</tr>
<tr>
<td>painted [pintó]</td>
<td>1158</td>
</tr>
<tr>
<td>washed [lavó]</td>
<td>1762</td>
</tr>
<tr>
<td>moved [movió]</td>
<td>1771</td>
</tr>
<tr>
<td>pushed [empujó]</td>
<td>1877</td>
</tr>
<tr>
<td>lifted [levantó]</td>
<td>2511</td>
</tr>
<tr>
<td>touched [tocó]</td>
<td>3448</td>
</tr>
<tr>
<td>kicked [pateó]</td>
<td>4078</td>
</tr>
</tbody>
</table>

*Control sentences.* A total of 10 disambiguated sentences were also created to serve as controls, both in Spanish and in English. In English, gaps are created when there is a syntactic or semantic constituent that temporarily interrupts the canonical order (S-V-O) of the sentence (Kroeger, 2005). For example, in the sentence, *The woman who saw the man that worked at the firm went to the bank*, the relative clause *who saw the man that worked at the firm*, causes a gap between the main clause subject (the woman) and the main clause object (firm). These gaps require the reader to retain information relating
to the main clause subject in working memory until he or she can connect this information to the main clause object. These gaps often make the processing of these sentences difficult.

Control sentences without the gap were constructed in Spanish and in English to help in the analysis of the effects of gaps (which are present in the relative clause sentences) in sentence processing. These control sentences were created using the same set of nouns and verbs as found in the sentences that contained relative clauses. However, in the control sentences, the relative clause was replaced with a prepositional phrase in order to eliminate the presence of the gap. Therefore, a total of 10 prepositional phrases were selected to replace the relative clauses in the experimental stimuli. Four of the prepositional phrases contained three syllables, while six of the prepositional phrases contained four syllables. Each prepositional phrase was only used once. Table 6 below contains a listing of the prepositional phrases that were selected.

Table 6

Ten Prepositional Phrases Selected to Construct Control Sentences

<table>
<thead>
<tr>
<th>Three-syllable preposition</th>
<th>Four-syllable prepositions</th>
</tr>
</thead>
<tbody>
<tr>
<td>detrás de [behind]</td>
<td>al frente de [in front of]</td>
</tr>
<tr>
<td>lejos de [far from]</td>
<td>encima de [on top of]</td>
</tr>
<tr>
<td>cerca de [near]</td>
<td>abajo de [under]</td>
</tr>
<tr>
<td>sobre la [over]</td>
<td>al lado de [next to]</td>
</tr>
<tr>
<td></td>
<td>arriba de [on top of]</td>
</tr>
<tr>
<td></td>
<td>delante de [in front of]</td>
</tr>
</tbody>
</table>
**Picture probes.** Pictures were created to illustrate each sentence heard by the participants in order to reduce memory load. Memory load was reduced because there is research supporting that memory capacity may play a factor in syntax processing (Domenico & Matteo, 2009; Felser, et al., 2003). Thus, each Spanish and English sentence was accompanied by a picture pair that portrayed its meaning. For example, for the sentence, *The boy touched the grandfather that kicked the man,* a set of two pictures was presented on the computer screen. The first picture depicted a boy touching the grandfather, and the second picture illustrated the grandfather kicking the man. Figure 3 below provides an example of how the picture pairs were used to represent one sentence.

![Example of true condition pictures used to represent sentences](image)

*Figure 3.* Example of true condition pictures used to represent sentences

A total of 100 pictures were hand-drawn. Fifty of the pictures were drawn to match the sentence, while the other 50 pictures were drawn so that the sentence and the picture presented on the computer did not match. The illustrations for the false condition were created by having one of the other humans in the sentence carrying out one of the actions in the second picture. For example, for the sentence, *The boy touched the*
grandfather that kicked the man, the second illustration in the picture depicted a boy kicking the man. Thus, the false pictures depicted an erroneous shift in perspective. An example of a picture illustrating the false condition is presented in Figure 4 below.

Figure 4. Example of false condition pictures used to represent sentences

In order to ensure that the pictures selected to represent each sentence were not ambiguous, the picture/sentence sets were shown to 20 graduate students in the Department of Communication Sciences and Disorders at a local university on the west coast of Florida. A handout containing printed copies of the pictures and their corresponding sentences (like in Figure 3) was given to each graduate student who participated. The graduate student was instructed to read each sentence and determine if the pictures presented matched the sentence. In the handout, each slide contained a picture and sentence that was accompanied by a yes/no question in which the participants were instructed to select whether the picture illustrated the sentence presented. After one week, the experimenter collected the handouts and calculated the percentage of agreement for each sentence/picture set. If there was less than 90% agreement on a
particular picture/sentence set, the picture was deleted from the pool of pictures. The pictures were then replaced with additional pictures created by the experimenter. The new pictures added to the pool of pictures were also evaluated by a group of graduate students using the procedures described above.

**Language screenings.** Two subtests from the *Clinical Evaluation of Language Fundamentals*-English (CELF-4; Semel, Wiig, & Secord, 2003) and two subtests from the *Clinical Evaluation of Language Fundamentals-Spanish* (CELF-4 Spanish; Semel, Wiig, & Secord, 2006), as well as a Second Order False-Belief Theory of Mind task (Silliman et al., 2003) were used as part of the language screenings. These assessments are described in detail below.

*Clinical Evaluation of Language Fundamentals 4.* The *Clinical Evaluation of Language Fundamentals 4* (CELF-4, Semel, Wiig, & Secord, 2003) is a standardized assessment developed to evaluate language performance in individuals ranging from 5 to 21 years of age. The Spanish and English versions of the *Concepts and Following Directions* and *Understanding Spoken Paragraphs* subtests of the CELF-4 were administered to the bilingual participants as part of the language screening procedures. Only the English subtests were administered to the monolingual participants.

Although the Spanish edition of the CELF-4 (Semel, Wiig, & Secord, 2006) is similar to the English version, the items in the Spanish version are not a direct translation from English. The Spanish version of the CELF-4 was normed across various Spanish-speaking populations in the United States. The proportion of dialects represented on the CELF-4-Spanish edition is as follow: 45.88% Mexican, 28.00%, Central and South,
18.13%, Puerto Rican, 4.50%, Dominican, and 2.25% Cuban. Thus, this assessment has a representative sample of the major Spanish-speaking dialects spoken in the United States.

The Concepts and Following Directions subtest of the CELF-4 (Semel, Wiig, & Secord, 2003) was used to assess participants’ ability to interpret spoken directions of increasing length and complexity. The oral directions given required the completion of logical operations by remembering names, characteristics, and the order of the mentioned objects. In this subtest, participants were instructed to point to objects in the stimulus book in response to the oral directions given. The Spanish version of the subtest includes parallel, but not translated, items that assess the same concepts as the English version. In the Spanish edition, alternate vocabulary is provided to account for dialectical variations (e.g., carro [car], pelota [ball]). The English version of this subtest yielded an internal consistency reliability coefficient of .89 (Cronbach’s coefficient alpha ≥ .90 indicates excellent reliability). In Spanish, the internal consistency reliability was .88, which indicates adequate reliability.

The Understanding Spoken Paragraphs subtest of the CELF-4 (Semel, Wiig, & Secord, 2003; 2006) was used to evaluate the participants’ ability to (a) sustain attention and focus while listening to spoken paragraphs of increasing length and complexity, (b) understand oral narrative and texts, (c) answer questions about the content of information given, and (d) think critically to arrive at logical conclusions. In this subtest, participants were instructed to answer questions related to each of the short paragraphs that were read to them. Both the Spanish and English editions of the subtest include three paragraphs, one about home routines, one about familiar school routines, and one that is curriculum-based. The English subtest yielded an internal consistency reliability
coefficient of .73. The Spanish subtest yielded an internal consistency reliability coefficient of .82. Both versions have acceptable reliability.

*Second order false-belief task.* Second-order theory of mind refers to individuals’ ability to think about their own thinking in regard to other’s thoughts and beliefs (Silliman et al., 2003). For a child to master second-order theory of mind, he/she must coordinate multiple perspectives about what two characters are thinking in a situation in which the child knows the conflicting beliefs, but the characters do not. Silliman et al.’s (2003) *second order false-belief tasks* were used to assess the participants’ ability to coordinate multiple perspectives for logical and social inferencing. Logical inferencing tasks refer to physical casualty, while social inferencing refers to psychological casualty. One second-order logical inferencing task (Pam’s story) and one second-order social inferencing task (Frank’s story) were used during this language screening. These second-order false belief tasks required the participants to listen to the stories and answer questions, including second order questions, about each of the stories. The stories were accompanied by illustrations that corresponded to each scene in the stories. A binder was used to compile the illustrations presented for each scene in the stories (see Appendix D to view a sample of the materials used for the false-belief theory of mind tasks). On the second-order false belief tasks, Silliman et al. (2003) reported that inter-rater reliability measures yielded a Cohen’s Kappa of 1.0 for the logical inferencing task and .76 for the social inferencing task. These measures indicated the reliability of examiners’ scoring decisions were well-beyond chance.
**Language use questionnaire.** Spanish and English questionnaires were developed to assess the participants’ language use at home (See Appendices E-F). Questions were created to gather information on the participants’ age of language acquisition, language use at home, country of origin, and education outside of the United States. Parent reports on language-use questionnaires have been found to be reliable in identifying language use at home (Gutierrez-Clellen & Kreiter, 2003).

**Programming of experiment.** All of the sentences and their corresponding pictures were programmed on the same Dell Inspiron Laptop PC using Mouse Tracker Software (Freeman & Ambady, 2010). Two separate experiments were programmed, one in Spanish and one in English. In both experiments, the participants were allotted 15,000 ms to respond to each trial. In both experiments, a start screen was presented prior to the initiation of each trial. The start screen consisted of a “start” button at the bottom center of the screen, and response buttons “yes” and “no” located in the upper left and right corners of the screen. The “yes” and “no” response buttons were situated equally from the center of the screen (the response buttons in the Spanish experiment were in Spanish). Figure 5 below shows an example of the start screen presented at the beginning of each trial.
For each trial, a stimuli screen was also constructed to appear after the participants clicked “start” on the start screen. The stimuli screen showed a picture centered in the middle of the screen and the response buttons “yes” and “no” located in the upper left and right corners of the screen. For each trial, the picture appeared immediately after clicking the start button. The picture remained on the screen until the participant clicked on a response. Figure 6 below shows an example of stimuli screen.

*Figure 5. Mouse tracker start screen*
A sentence corresponding to the picture was presented two seconds after the picture was presented. The sentences in both of the experiments were presented in the same order. For the Spanish experiment, a native Spanish speaker recorded the sentences used in the study. For the English experiment, a native English speaker recorded the experimental sentences. For both the Spanish and English experiments, all of the sentences were recorded in a sound attenuated booth using a MicroMic 420C microphone connected to Dell computer using Praat to record the stimuli (Boersma, & Weenink, 2011). In addition, all of the sentences recorded were standardized to be seven seconds in length, with an additional two seconds of silence at the beginning and end of the sentence recording. The duration of the sentences was standardized to facilitate Response Time.
(RT) calculations. Furthermore, all of the sentences were normalized for loudness levels (Root mean square (RMS)=16 dB using Audacity (Mazzoni, 2010).

Procedure

**Informed Consent.** Parental or legal guardian consent, as well as the participant’s assent, was required for participation in the experiment. For the participants recruited from the public school, the parent(s) or legal guardian(s) received the consent form from the classroom teacher. For the participants recruited from the university and afterschool programs, consent forms were handed out to parents, who returned the forms to the examiner if they wanted their child to participate in the study. Consent forms were written in Spanish and in English to insure that a consent form was available in the parent(s) or guardian(s) primary language. The parent(s)/guardian(s) read the consent form and had the opportunity to contact the principal investigator (who was a native speaker of Spanish), in case they may had any questions. Once the informed consent was returned to the teacher or directly to the principal investigator, the principal investigator scheduled testing for the child. At the first testing session, the child was briefed as to the nature of the experiment and their assent was obtained verbally. If the child did not want to participate, he/she could then return to the classroom, the afterschool room, or home (depending on the setting) and was discontinued from the study without penalty.

**Test administration.** The testing procedures were conducted over the course of one to three days, depending on the language(s) spoken by the participant. The monolingual participants completed the experiment over the course of one to two days, as allowed by their schedule. Bilinguals completed the experiment over the course of three days in order to account for fatigue that may have occurred during the experimental tasks.
All sessions were completed within a two week time frame. The experiment was completed by two investigators. The assistant investigator completed the audiometric and language screenings and the principal investigator (PI) administered the experimental tasks. The PI trained the assistant investigator in the screening procedures and monitored test administration and scoring.

On the first day of testing, the children were individually brought from their classrooms or afterschool room (as applicable) into a quiet room by the experimenter. Assent was solicited upon arrival. The participants then completed an audiometric screening, language screenings in Spanish and English (as appropriate), and a second order false belief task in English. The order of the screenings was randomized in order to account for fatigue. The first session lasted approximately 30 minutes for the monolingual participants, and approximately 50 minutes to an hour for the bilingual participants. Once the children completed the screenings, they received a small toy for their work.

The second and/or third day of testing occurred within two weeks of the first session. The children were once again picked up individually by the experimenter and taken to a quiet room. After entering the test room, they were asked to sit down in front of a laptop computer. The children were instructed as to the nature of the task and be given a set of earphones to wear. The headphones were cleaned after each use with anti-bacterial wipes.

Prior to the start of the experiment, a trial run using Mouse Tracker Software (Freeman & Ambandy, 2010) was used to familiarize the children with the equipment and task. The sentences used in the trial were constructed in the same way as the
sentences in the experiment, but they were different from those presented in the experiment. During the trial session, the researcher only provided verbal feedback for the participants’ completion of the task (i.e., listening to the whole sentence before responding), but did not provide any feedback on the participants’ accuracy of responses. Once the investigator felt the child had attained an understanding of the task, the experiment began.

**Instructions.** During the experimental portion of the task, the participants were told that they would be listening to sentences, and that some sentences may sound silly. They were instructed to listen to the sentences, and determine if the two pictures presented for the sentence accurately depicted its meaning. The participants used a mouse to click *yes* or *no* on the computer screen. They were also instructed to answer as quickly as they could in order to collect response time (RT) data (see Appendix G for detailed instructions).

**Experimental task administration.** After the instructions were read to each of the participants, the experimental task began. The experimental session(s) took approximately 30 minutes to complete. The Spanish and English experiments were completed separately. Also, the order in which the Spanish-English bilinguals completed each experiment (Spanish or English) was randomized. The monolingual speakers only completed the English part of the experiment. In addition, the order in which the perspective shifting and the control sentences were presented was quasi-randomized.

For each trial, a start button appeared in the center of the computer screen until the participant clicked on the button. Then, the mouse cursor automatically centered itself and a pair of pictures depicting the sentence appeared in the middle of the screen. For
each experimental trial, the participants had to decide whether the sentences they heard matched the picture that was presented on the computer screen by clicking on the response buttons yes or no.

**Data Reduction.**

Mouse Tracker Software (Freeman & Amabandy, 2010) was used to collect data regarding each participant’s response time and level of accuracy. Response times were collected by recording the duration from when the participant clicked on the start button to when he or she selected a yes/no response. Participant responses to each sentence were collected using the Mouse Tracker software, so that accuracy levels by sentence condition could be determined later in Excel.

**Accuracy levels and response time.** For each participant, accuracy levels were determined for each sentence type by calculating the percentage of correct responses. Percent accuracy was calculated using the following formula:

\[
\text{Percent Accuracy} = \frac{\text{Total Correct Responses}}{\text{Total Number of Trials}}
\]

Participants that obtained 50% or less accuracy on the control sentences in either language were excluded from the study because this indicated performance at chance levels.

**Signal detection theory.** Signal detection theory was utilized to determine a participant’s reliability in responding. This process was completed to discriminate participants’ bias for selecting a particular response. Signal Detection Theory measures a participant’s bias for a particular response while completing a cognitive task (Green & Swets, 1975). In this analysis, listener sensitivity is measured by using the d’ (d prime)
parameter. This parameter is calculated by first, determining the participant’s hits (responds “yes” when it is yes) and false alarms (responds “yes” when it is no). These percentages are then converted to standard normal distribution z-scores. D’ is the calculated by using the following formula:

\[ d' = z_{\text{Hits}} - z_{\text{False alarms}} \]

For example, if a listener has a hit rate of .8 and a false alarm rate of .3, \( d' = z(0.8) - z(0.3) = 0.842 - (-0.253) = 1.095 \). If \( d' = 0 \), this indicates that the participants were not sensitive to whether the perspective shifting sentence they heard matched the picture they saw. As \( d' \) increases, this indicates that the participants increased their probability of saying that the perspective shift sentence they heard matched the picture when it was true.

Finally, response time data were collected for each sentence type in English and Spanish (as applicable). Response time was measured from the onset of the stimuli presentation to the time the participant selected a response. In order to account for longer response times, which may be indicative of participants’ loss of focus, restricted means were computed following the recommendations by Miller (1993). Following Miller’s proposed methodology, the average and standard deviation of all response times for each condition were computed. Next, the response times were discarded that fell three standard deviations below or above the mean. Finally, the average response time for each condition was recalculated with the outliers thrown out. This method of computing restricted means has been shown to appropriately estimate the actual population of reaction times.
Data Analysis

The independent variables were grade, gender, language (Spanish vs. English) and sentence type (4 switches and control sentences). The dependent variables were percent accuracy, d’, and response time. Six multivariate analyses of variance (MANOVAs) were run, one for each dependent variable when considering across group (monolingual vs. bilingual) comparisons and when looking across languages (Spanish vs. English) for the bilingual group. Post hoc analyses were conducted as needed and effect sizes were calculated.
Chapter 3

Results

The primary purpose of this study was to investigate bilinguals’ L1 vs. L2 processing of relative clauses in sentences containing increasingly complex shifts in perspective. The secondary purpose of this study was to compare bilingual and monolingual speakers’ processing of English relative clause sentences, in order to determine if differences in performance existed across language groups. In order to determine processing difficulty, accuracy and response time data were collected for analysis. In line with MacWhinney’s (2005) Perspective Hypothesis, it was believed that sentences with easier shifts in perspective would result in higher levels of accuracy. Therefore, it was predicted that the four types of relative clause sentences would yield the following order of difficulty: SS (0 switch) > OS (1-) = OO (1+) > SO (2 switch) in Spanish and English for the bilingual speakers, and in English for the monolingual speakers. It was also hypothesized that differences in response time (RT) would relate to the ease of the perspective shift, with easier perspective shifts yielding faster response times. Therefore, RT SS (0 switch) < RT OS (1-) = RT OO (1+) < RT SO (2 switch). Furthermore, it was predicted that there would be no differences in RT for the bilingual group when processing sentences in their L1 and L2, or between the bilingual and monolingual speakers for the English sentences.
Selection of Independent Variables

Given the potential number of independent variables in this study, an attempt was made to simplify the data analysis. Therefore, the potential influences of gender and grade were examined to determine if these factors should remain in the analyses. A 3-way MANOVA was run for each dependent variable (percent accuracy, d’, and RT). Independent variables were grade, gender and sentence type. The results of all three MANOVAs were the same. There was no significant interaction for grade or gender and the main effects of grade and gender were not significant. Only the main effect of sentence type was significant, which is the focus of the other analyses to come.

In the same way, the influences of gender and grade were analyzed for the bilingual participant’s performances on the Spanish sentences. Since the number of students in this analysis was smaller, nonparametric analyses were run. A series of Mann-Whitney U tests comparing percent accuracy, d’, and RT scores within sentence type in Spanish were run. Given the number of tests run, the significance level was set at $p = 0.01$. Once again, there were no differences within sentence type attributed to gender or grade. Given these results, each participant group (bilingual and monolingual) was collapsed across gender and grade. Thus, further analyses were conducted on a total of 16 bilingual speakers and 12 monolingual speakers. The results from these analyses are described in the sections below.
Performance of Bilingual Participants in Their L1 and L2

For the bilingual participants, the study involved two within-subject independent variables: language with two levels (Spanish and English) and sentence type with five levels (0 switch, 1-, 1+, 2 switch, and control). The dependent variables in this study included the indicators of accuracy (percent accuracy and d’) and RT for each sentence type. Three multivariate analyses of variance (MANOVAs) were conducted to note differences in sentence processing across switch types within and between language groups.

Accuracy results for the bilingual participants in their L1 and L2. In order to evaluate which of the perspective shift sentences were most difficult for the bilingual participants, percent correct was calculated in both Spanish and English for each sentence type. The participants in the study who obtained 50% or less accuracy on the control condition in either language were excluded from the analysis in order to insure the participants understood the task. As a result of this criterion, four bilingual participants and one monolingual participant were excluded from further analysis. Table 7 below compares the average percent accuracy for each perspective shift sentence in Spanish and in English for the 12 remaining bilingual participants.
Table 7

*Mean Percent Accuracy (standard deviations in parenthesis) for Each Sentence Type in Spanish and English for the Bilingual Participants*

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Accuracy (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spanish</td>
<td>English</td>
<td>Both Languages</td>
</tr>
<tr>
<td>0 switch</td>
<td>75% (0.15)</td>
<td>69% (0.15)</td>
<td>72% (0.15)</td>
</tr>
<tr>
<td>1 minus</td>
<td>55% (0.11)</td>
<td>61% (0.13)</td>
<td>58% (0.20)</td>
</tr>
<tr>
<td>1 plus</td>
<td>50% (0.08)</td>
<td>56% (0.10)</td>
<td>53% (0.09)</td>
</tr>
<tr>
<td>2 switch</td>
<td>53% (0.19)</td>
<td>55% (0.18)</td>
<td>54% (0.19)</td>
</tr>
<tr>
<td>Control</td>
<td>72% (0.14)</td>
<td>75% (0.11)</td>
<td>74% (0.13)</td>
</tr>
</tbody>
</table>

A multivariate ANOVA (MANOVA) was completed to note differences attributable to sentence type across languages in terms of task accuracy. A summary of the results obtained on this analysis is provided in Table 8 below.

Table 8

*MANOVA Summary Table: Effects of Language and Sentence Type on Bilingual Participants’ Accuracy Levels. Significant findings are bolded*

<table>
<thead>
<tr>
<th>Effect</th>
<th>F</th>
<th>df</th>
<th>p value</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>0.629</td>
<td>1,11</td>
<td>.444</td>
<td>.054</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>14.827</td>
<td>4,44</td>
<td><strong>.000</strong></td>
<td>.574</td>
</tr>
<tr>
<td>Language &amp; Sentence Type Interaction</td>
<td>1.122</td>
<td>4,44</td>
<td>.358</td>
<td>.093</td>
</tr>
</tbody>
</table>
The results of this analysis revealed that neither the main effect for language nor the interaction between language and sentence type were significant. These findings suggest that the bilingual participants’ accuracy levels on the sentence task were similar in Spanish and English.

The analysis did reveal a main effect for sentence type, $F(4, 44) = 14.827, p < 0.001$, $\eta_p^2 = 0.574$, with a large effect size. These findings suggest that significant differences in sentence type existed independent of language. Post hoc analyses with the Bonferroni technique revealed that the level of accuracy for the 0 switch condition was greater than the accuracy of the 1- ($p = .009$) and 1+ ($p = .001$) conditions. Additionally, the accuracy level for the control condition was greater than all of the conditions, except the 0 switch ($p = 1.00$). As seen in Figure 7, the bilingual participants’ accuracy level was greater for the 0 switch and the control sentence types, with no significant differences across sentences involving a perspective shift.

![Figure 7. Bilingual participants’ mean percent accuracy for each sentence type](image-url)
Signal detection theory was applied to supplement the accuracy scores by determining the participants’ reliability in responding by controlling for guessing. Signal detection yields d’ scores, and when these d’ values are equal to or greater than one, it indicates that the participants understand the experimental task. As illustrated in Table 9, the average d’ for each sentence type was either approximating or greater than 1, verifying the participants’ ability to perform the task.

Table 9

*Mean d’ Values for Each Sentence Type across Languages (standard deviation in parenthesis) for the Bilingual Participants*

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Mean d’ Values</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spanish</td>
<td>English</td>
<td>Both Languages</td>
<td></td>
</tr>
<tr>
<td>0 switch</td>
<td>3.28 (3.07)</td>
<td>3.07 (3.15)</td>
<td>3.18 (3.11)</td>
<td></td>
</tr>
<tr>
<td>1- switch</td>
<td>0.86 (1.33)</td>
<td>2.51 (2.82)</td>
<td>1.68 (2.08)</td>
<td></td>
</tr>
<tr>
<td>1+ switch</td>
<td>0.99 (1.56)</td>
<td>2.25 (3.09)</td>
<td>1.62 (2.33)</td>
<td></td>
</tr>
<tr>
<td>2 switches</td>
<td>1.08 (1.26)</td>
<td>0.97 (1.11)</td>
<td>1.02 (1.19)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>3.17 (2.97)</td>
<td>2.08 (1.25)</td>
<td>2.62 (2.11)</td>
<td></td>
</tr>
</tbody>
</table>

A two-way MANOVA was conducted to determine differences in d’ attributable to language and sentence type in the bilingual participants. The results of the MANOVA are provided in Table 10 below.
Table 10

**MANOVA Summary Table: Effects of Language and Sentence Type in the Bilingual Participants’ d’ Scores. Significant findings are bolded**

<table>
<thead>
<tr>
<th>Effect</th>
<th>F</th>
<th>df</th>
<th>p value</th>
<th>$\eta_p^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>0.489</td>
<td>1,11</td>
<td>.499</td>
<td>.043</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>6.795</td>
<td>4,44</td>
<td>.000</td>
<td>.382</td>
</tr>
<tr>
<td>Language &amp; Sentence Type Interaction</td>
<td>3.217</td>
<td>4,44</td>
<td>.021</td>
<td>.226</td>
</tr>
</tbody>
</table>

As illustrated above, the main effect for language was not significant. These results indicate that the bilingual participants’ d’ scores were similar in both Spanish and English.

The analysis also revealed a significant interaction between language and switch type, $F (4, 44) = 3.217, p = 0.021, \eta_p^2 = 0.226$, with a small-moderate effect size. Post-hoc analyses for the interaction were conducted using paired samples t-tests with a Bonferroni correction ($p \leq 0.002$) to determine which sentence types differed within each language. These results revealed that only one out of the 20 pairwise comparisons of interest were significant. This difference was between the 0 switch and 1+ switch condition ($p \leq .001$) in Spanish. (see Figure 8). There were no significant differences for any of the pairwise comparisons in English. Given the degree of variability in these data and only one pairwise comparison of significance, this interaction will not be considered further.
Like the previous analysis, a significant main effect for sentence type, $F(4, 44) = 6.795$, $p < 0.001$, $\eta_p^2 = 0.382$, with a moderate effect size was noted. Post-hoc analysis using the Bonferroni technique ($p < 0.05$) was completed to determine which sentence types led to significant differences in $d'$ scores. The results from this analysis indicated that the 0 switch was easier than the 1+ condition, and the control condition was easier than the 1- condition. Once again, there was no difference between the control and 0 switch conditions and across the more difficult perspective shifts, indicating that the 1-, 1+, and 2 switch conditions were equally difficult.

A receiver operator characteristic (ROC) curve can be used to illustrate participants’ sensitivity to responding correctly on a task (Green & Swets, 1975). Graphs containing ROC curves are plotted with the false alarm rate on the horizontal axis, and the hit rate on the vertical axis. In addition, graphs illustrating ROC curves contain a criteria level indicated by a diagonal line that originates at the zero axis (the criterion line
is dashed in Figure 9). The further away a ROC curve is from the criteria line, the more confident one can be that the participants understood the task. On the other hand, if an ROC curve is near, or below, the criteria line, then one can conclude the participants had difficulty with a task. As seen in Figure 9, the ROC curve for the 0 switch and control conditions are further from the criteria line, corresponding to a larger d’. This finding suggests that the participants had increased sensitivity to these sentence types. On the other hand, the 1+ and 2 switch conditions are closer to the criteria line, corresponding to a smaller d’ and suggesting the participants had less sensitivity to these sentence types. These results support the accuracy analysis, which revealed that in general, the participants had performed more poorly on the 1+ and 2 switch conditions.

Figure 9. Mean Hit and False Alarm Rates for the Bilingual Participants for Each Sentence Type
Response times for the bilingual participants across languages. In order to further verify MacWhinney’s (2005) Perspective Hypothesis, RTs were measured for each sentence type with the idea that more complex sentences would take longer to process. Response time was measured from the onset of the stimuli presentation to the time the participant selected a response. In order to account for longer response times, which may be indicative of participants’ loss of focus, restricted means were computed following the recommendations by Miller (1993). Table 11 below demonstrates the average RT and standard deviation for all conditions.

Table 11

Average Response Time (standard deviation in parenthesis) in Milliseconds for Each Sentence Type in Spanish and English for the Bilingual Participants

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Mean Response Time (ms)</th>
<th>Spanish</th>
<th>English</th>
<th>Both Languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 switch</td>
<td>8614.89 (1638.56)</td>
<td>8663.02</td>
<td>8638.95 (1667.72)</td>
<td></td>
</tr>
<tr>
<td>1-switch</td>
<td>8343.28 (1795.00)</td>
<td>8880.15</td>
<td>8611.71 (1387.89)</td>
<td></td>
</tr>
<tr>
<td>1+ switch</td>
<td>9678.75 (2449.37)</td>
<td>9554.62</td>
<td>9616.68 (2367.00)</td>
<td></td>
</tr>
<tr>
<td>2 switch</td>
<td>8759.67 (1861.99)</td>
<td>8999.03</td>
<td>8879.35 (2285.43)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>8191.17 (1861.99)</td>
<td>8628.07</td>
<td>8409.62 (1503.85)</td>
<td></td>
</tr>
</tbody>
</table>

A two-way MANOVA was completed to note differences in RT across language and sentence type. The results of the MANOVA are provided in Table 12 below.
Table 12

**MANOVA Summary Table: Effects of Language and Sentence Type in the Bilingual Participants’ RT Data. Significant findings are bolded**

<table>
<thead>
<tr>
<th>Effect</th>
<th>F</th>
<th>df</th>
<th>p value</th>
<th>$\eta_p^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>0.306</td>
<td>1,11</td>
<td>.591</td>
<td>.027</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>4.818</td>
<td>4,44</td>
<td><strong>.003</strong></td>
<td>.305</td>
</tr>
<tr>
<td>Language &amp; Sentence Type Interaction</td>
<td>0.401</td>
<td>4,44</td>
<td>.807</td>
<td>.035</td>
</tr>
</tbody>
</table>

As illustrated above, the results revealed that the main effect for language was not significant. These findings indicate that there were no significant differences in RT between the bilingual participants’ performances in Spanish and English.

The main effect for sentence type was significant, with a moderate effect size, $F$ (4, 44) = 4.818, $p = 0.003$, $\eta_p^2 = .0305$. Post-hoc analysis using the Bonferroni technique revealed that the response times were longer for the 1+ than the 1- ($p = 0.054$) and control conditions ($p = 0.014$) (see Figure 10). The difference between the 1+ and 0 switch condition ($p = 0.054$) approached significance; however there was no significant difference between the 1+ and 2 switch sentences. These findings suggest that response times were longer with the more difficult 1+ sentences.
Figure 10. Mean response times for the sentence types for the bilingual participants

Bilingual and Monolingual Speakers’ Performance on the English Relative Clauses

The same analyses were conducted to note if native language affected a participant’s performance on relative clause comprehension in English. The results of these analyses are described below.

**Accuracy across language groups.** A two-way MANOVA was conducted to evaluate if bilingual and monolingual speakers process English relative clauses differently. Table 13 below lists the average accuracy levels for each sentence type in this MANOVA.
Table 13

Mean Percent Accuracy for Each Sentence Type in English (Standard Deviation in Parenthesis) Across Language Groups

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Bilingual Speakers</th>
<th>Monolingual Speakers</th>
<th>All Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 switch</td>
<td>69% (0.15)</td>
<td>80% (0.16)</td>
<td>74% (0.15)</td>
</tr>
<tr>
<td>1- switch</td>
<td>61% (0.13)</td>
<td>77% (0.16)</td>
<td>69% (0.16)</td>
</tr>
<tr>
<td>1+ switch</td>
<td>56% (0.10)</td>
<td>60% (0.17)</td>
<td>58% (0.14)</td>
</tr>
<tr>
<td>2 switch</td>
<td>56% (0.18)</td>
<td>63% (0.11)</td>
<td>59% (0.15)</td>
</tr>
<tr>
<td>control</td>
<td>75% (0.11)</td>
<td>78% (0.15)</td>
<td>77% (0.12)</td>
</tr>
</tbody>
</table>

This analysis was completed to determine if there was a significant difference in the accuracy levels across sentence types and across language groups. Since the values in this analysis were not equally distributed, a Greenhouse-Geisser correction was applied (Mauchly’s Test of Sphericity was significant, $p = 0.002$). The results of the MANOVA are summarized in Table 14 below.
Table 14

**MANOVA Summary Table: Effects of Language and Sentence Type in Levels of Accuracy Across Language Groups. Significant findings are bolded**

<table>
<thead>
<tr>
<th>Effect</th>
<th>F</th>
<th>df</th>
<th>p value</th>
<th>η²p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Group</td>
<td>4.157</td>
<td>1,23</td>
<td>.053</td>
<td>.153</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>14.852</td>
<td>2.829,65.065</td>
<td>.000</td>
<td>.392</td>
</tr>
<tr>
<td>Language Group &amp; Sentence Type Interaction</td>
<td>1.474</td>
<td>2.929,65.065</td>
<td>.231</td>
<td>.060</td>
</tr>
</tbody>
</table>

The interaction between language group and sentence type was not significant and the main effect for language group approached significance, $F(1, 23) = 4.157, p < .053$, $η²p = .153$. The latter finding indicates that the monolingual participants were more accurate than the bilingual participants when processing complex relative clauses in English. However, these results will not be considered further since the effect size was small and the results from the other analyses did not support this finding.

The analysis also revealed a significant main effect for sentence type, with a moderate effect size, $F(2.829, 65.065) = 14.852, p < .001, η²p = .392$. Post hoc testing with the Bonferroni technique ($p < 0.05$) revealed that 1+ and 2 switch sentences were identified less accurately than the 0 switch and control sentences (see Figure 11). In addition, the accuracy on the 1+ sentences was less than the 1- sentences. These findings suggest that percent accuracy levels were higher for the less complex sentence types (i.e., control, 0 switch, and 1- switch sentences).
Figure 11. Mean percent accuracy for each sentence type across language groups

As previously described, signal detection theory was utilized to support the accuracy results. Table 15 below illustrates the average d' for each sentence type across language groups. As seen in Table 15, the average d' values for each sentence type across both language groups were greater than 1; therefore, it can be stated with confidence that the participants understood the task.
Table 15

Mean d’ for Each Sentence Type (Standard Deviations in Parenthesis) across Language Groups

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Bilingual Speakers</th>
<th>Monolingual Speakers</th>
<th>All Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 switch</td>
<td>3.37 (3.21)</td>
<td>2.75 (2.81)</td>
<td>3.07 (2.97)</td>
</tr>
<tr>
<td>1- switch</td>
<td>2.85 (2.97)</td>
<td>3.42 (2.81)</td>
<td>3.12 (2.85)</td>
</tr>
<tr>
<td>1+ switch</td>
<td>2.62 (3.23)</td>
<td>1.62 (2.17)</td>
<td>2.14 (2.76)</td>
</tr>
<tr>
<td>2 switch</td>
<td>1.16 (1.27)</td>
<td>1.32 (1.25)</td>
<td>1.24 (1.24)</td>
</tr>
<tr>
<td>Control</td>
<td>2.19 (1.26)</td>
<td>2.16 (1.31)</td>
<td>2.17 (1.26)</td>
</tr>
</tbody>
</table>

A two-way MANOVA was completed to determine if there were significant differences in d’ scores across language groups and sentence types. Since the values in this analysis were not equally distributed, a Greenhouse-Geisser correction was applied (Mauchly’s Test of Sphericity was significant, \( p = 0.003 \)). A summary of the results from the MANOVA are provided in Table 16 below.

Table 16

MANOVA Summary Table: Effects of Language Group and Sentence Type in d’ Scores for the Bilingual and Monolingual Speakers. Significant findings are bolded

<table>
<thead>
<tr>
<th>Effect</th>
<th>F</th>
<th>df</th>
<th>( p ) value</th>
<th>( \eta_p^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Group</td>
<td>.063</td>
<td>1,23</td>
<td>.804</td>
<td>.003</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>5.237</td>
<td>2.989,68.752</td>
<td>.003</td>
<td>.185</td>
</tr>
<tr>
<td>Language Group &amp; Sentence Type Interaction</td>
<td>.841</td>
<td>2.989,68.752</td>
<td>.503</td>
<td>.035</td>
</tr>
</tbody>
</table>
The MANOVA did not reveal a significant main effect for language groups, $F(1, 23) = .063, p = .804, \eta_p^2 = .003$. These results suggest that the $d'$ scores were similar for the bilingual and monolingual participants.

There was a significant main effect for sentence type with a small effect size, $F(2.989, 69.752) = 5.237, p = .003, \eta_p^2 = 0.185$. Post-hoc analysis using the Bonferroni technique ($p \leq 0.05$) indicated that the 0-switch, 1-switch, and control sentences were easier than the 2-switch sentences. No differences were noted for the other pairs; hence, the participants performed similarly in these conditions. As shown in Figure 12, the receiver operator characteristic (ROC) curves illustrate that the control, 0, and 1-switch conditions were furthest from the criteria line, indicating listener confidence for these sentence types. On the other hand, the 1+ and 2-switch condition ROC curves were closest to the criteria line. This suggests that the participants had less sensitivity to these sentence types.

![Figure 12. Mean hit and false alarm rates across language groups for each sentence type](image)

Figure 12. Mean hit and false alarm rates across language groups for each sentence type
Response time across language groups. In order to further compare processing of relative clauses in English sentences across language groups, RT measures were calculated using the same procedures as described in previous sections. Table 17 below shows the average response time each sentence type across language groups.

Table 17

Mean Response Time for Each English Sentence Type (Standard Deviations in Parenthesis) in Milliseconds across Language Groups

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Average Response Time (ms)</th>
<th>Bilingual Speakers</th>
<th>Monolingual Speakers</th>
<th>All Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8649.6 (1625.35)</td>
<td>8434.5 (1329.56)</td>
<td>8546.35 (1163.95)</td>
</tr>
<tr>
<td>1- switch</td>
<td></td>
<td>8810.0 (972.46)</td>
<td>9187.7 (1744.65)</td>
<td>8991.32 (1380.22)</td>
</tr>
<tr>
<td>1+ switch</td>
<td></td>
<td>9466.70 (2210.97)</td>
<td>10603.4 (2636.25)</td>
<td>10012.33 (2442.43)</td>
</tr>
<tr>
<td>2 switch</td>
<td></td>
<td>8859.7 (1309.14)</td>
<td>9977.6 (2742.44)</td>
<td>9396.32 (2151.50)</td>
</tr>
<tr>
<td>control</td>
<td></td>
<td>8512.3 (1499.11)</td>
<td>8490.2 (1680.76)</td>
<td>8501.88 (1555.17)</td>
</tr>
</tbody>
</table>

A two-way MANOVA was completed to determine if there was a significant difference in RTs across sentence types and language groups. Since the values in this analysis were not equally distributed, a Greenhouse-Geisser correction was applied (Mauchly’s Test of
Sphericity was significant, \( p < 0.001 \). A summary of the results from this MANOVA is shown in Table 18 below.

Table 18

**MANOVA Summary Table: Effects of Language Group and Sentence Type in the RTs of the Bilingual and Monolingual Participants.** Significant findings are bolded

<table>
<thead>
<tr>
<th>Effect</th>
<th>( F )</th>
<th>df</th>
<th>( p ) value</th>
<th>( \eta_p^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Group</td>
<td>.535</td>
<td>1,23</td>
<td>.472</td>
<td>.023</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>11.225</td>
<td>2.555,58.774</td>
<td><strong>.000</strong></td>
<td>.328</td>
</tr>
<tr>
<td>Language Group &amp; Sentence Type</td>
<td>2.684</td>
<td>2.555,58.774</td>
<td>.036</td>
<td>.105</td>
</tr>
</tbody>
</table>

The analysis did not reveal a significant interaction for language group and sentence type or a main effect for language group. The latter results suggest that the RTs were similar for the bilingual and monolingual participants.

The analysis did reveal a significant main effect for sentence type, with a moderate effect size, \( F (2.555, 58.774) = 11.225, p < 0.001, \eta_p^2 = 0.328 \). Post-hoc testing with the Bonferroni technique (\( p \leq 0.05 \)) revealed that the average RT for the 1+ switch condition was longer than the average RT for the 0 switch (\( p < .001 \)) and the control condition (\( p < 0.001 \)). In addition, the RT for the 2 switch condition was longer than the control condition (\( p = 0.047 \)) (see Figure 13). There was no difference in RTs across the three sentence types involving a perspective shift.
Summary of Results

In this study, indicators of accuracy (percent accuracy and d’ data) and RTs were analyzed to determine the skill of bilingual speakers in processing complex relative clauses in Spanish and in English. Next, the performances of the bilingual group were compared to that of their monolingual counterparts on the relative clause task in English.

A significant main effect for sentence type was revealed for all of the dependent variables, across languages (Spanish and English for the bilingual participants) and language groups (bilingual versus monolingual participants). The accuracy analysis comparing bilingual participants’ performance on the Spanish and English sentences revealed that the levels of accuracy for the 0 switch condition were greater than the 1- and 1+ conditions. In addition, the accuracy levels for the control condition were greater for all of the sentences, with the exception of the 0 switch. The d’ analysis confirmed
that, in general, the participants had greater sensitivity to the 0 switch and control conditions. The RT analysis revealed that RTs were longer for the 1+ condition than the 1-, 0, and control conditions.

The second set of analyses compared the skills of bilingual speakers with monolingual speakers when processing complex relative clauses in English. The accuracy analysis revealed that the performances were higher for the 0 and control conditions than for the 1+ and 2 switch conditions. The participants were also more accurate in the 1- condition than the 1+. The d’ analysis confirmed that the participants had less sensitivity in the 1+ and 2 switch conditions, suggesting more difficulty in processing. In general, the ROC curves suggest that the participants were more accurate on the 0 switch, 1-switch, and control conditions, and less accurate on the 1+ and 2 switch conditions. Finally, the RT analysis revealed that the 1+ condition was longer than the 0 switch and control condition and the 2 switch sentences were more difficult than the control sentences.

In conclusion, a main effect for sentence type was found for all of the dependent variables when comparing across languages (Spanish vs. English) and across language groups (monolingual English vs. bilingual Spanish-English). As shown in Table 19, the differences found between the conditions were not always consistent across sentence types for each analysis. In general, the less complex sentences led to higher levels of accuracy and shorter RTs than the more complex sentence types. Interestingly, in general, the 2 switch condition was not consistently the most difficult condition, as predicted by MacWhinney (2005). Overall, the 1+ condition appeared to be most difficult.
Table 19

*Results of Accuracy, $D'$, and Response Time Analyses across Sentence Types*

<table>
<thead>
<tr>
<th>Analyses</th>
<th>Comparison</th>
<th>0 switch</th>
<th>1- switch</th>
<th>1+ switch</th>
<th>2 switch</th>
<th>control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>Bilinguals’ L1 and L2</td>
<td>&gt; 1-, 1+</td>
<td>&lt; 0 switch</td>
<td>&lt; 0 switch</td>
<td>&lt; control</td>
<td>&gt; all, except 0 switch</td>
</tr>
<tr>
<td></td>
<td>Bilingual &amp; Monolinguals in English</td>
<td>&gt; 1+, 2 switch</td>
<td>&gt; 1+</td>
<td>&lt; 0 switch, 1- switch</td>
<td>&lt; 0 switch, control</td>
<td></td>
</tr>
<tr>
<td><strong>$D'$</strong></td>
<td>Bilinguals’ L1 and L2</td>
<td>&gt; 1+</td>
<td>&lt; control</td>
<td>&lt; 0 switch</td>
<td>&gt; 1- switch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bilingual &amp; Monolinguals in English</td>
<td>&gt; 2 switch</td>
<td>&gt; 2 switch</td>
<td>&lt; 0 switch, 1- switch</td>
<td>&gt; 2 switch</td>
<td></td>
</tr>
<tr>
<td><strong>Response Time</strong></td>
<td>Bilinguals’ L1 and L2</td>
<td>0 switch</td>
<td>&lt; 1+</td>
<td>&gt; 1-, 0, control</td>
<td>&lt; 1+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bilingual &amp; Monolinguals in English</td>
<td>&lt; 1+</td>
<td>&gt; 0, control</td>
<td>&lt; control</td>
<td>&lt; 1+, control</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 4
Discussion

The primary aim of this study was to investigate the processing of complex relative clauses in elementary-aged Spanish-English bilingual students. The secondary purpose was to compare the performance of Spanish-English bilingual students with monolingual English speakers on the same relative clause task to note the influence of L1 on L2 processing. Six MANOVAs were completed to determine the effects of three independent variables (sentence type, language, and language group) on measures of accuracy (percent correct and d’) and RT. Results of the MANOVAs revealed a significant main effect for sentence type in all analyses, but no significant main effect for language or language group. These results indicated that the bilingual participants processed relative clauses similarly in Spanish and English. In addition, the bilingual and monolingual speakers’ performed similarly when processing the English sentences. In general, accuracy levels and d’ values were greater for the 0 switch and control conditions, and response times were longer for the more complex relative clauses, such as the 1+ condition.

The first prediction was that levels of accuracy would differ across sentences containing increasingly complex shifts in perspective, but that no differences in performance would be noted within the bilingual participants in Spanish and English, or between the bilingual and monolingual participants on the English relative clauses. These
sentence type predictions are in accordance with MacWhinney’s (2005) Perspective Hypothesis, which states that complex perspective shifts should result in lower accuracy levels. Therefore, it was predicted that the four types of relative clause sentences would yield the following order of difficulty: SS (0 switch) > OS (1- switch) = OO (1+ switch) > SO (2 switch).

The second prediction was that RT would differ across different sentence types involving shifts in perspective, but that no differences in performance would be noted within the bilingual participants in Spanish and English, or between the bilingual and monolingual speakers when processing English relative clauses. It was predicted that RTs would be indicative of processing ease; with sentences containing more complex shifts in perspective yielding longer RTs. Hence, RT SS (0 switch) < RT OS (1- switch) = RT OO (1+ switch) < RT SO (2 switch).

The following discussion will first address the results of this study as they relate to MacWhinney’s Perspective Hypothesis (2005a) and the literature currently available on relative clause processing. Next, preliminary theoretical implications on bilingual speakers’ processing of relative clauses will be discussed. Then, the clinical and educational implications of this study will be described. Finally, the strengths and limitations of this study, as well as further directions for research, will be stated.

Relative Clause Processing and the Perspective Hypothesis

The primary aim of this study was to investigate language processing by examining bilingual and monolingual children’s performances on tasks of relative clause processing. To this end, complexity of relative clause processing was determined by analyzing accuracy measures (percent correct and d’), as well as RT data. The results
from these three analyses primarily revealed a significant main effect for sentence type independent of language. In general, all of the analyses completed indicated that the control and 0 switch conditions were easier to process, while the 1+ condition consistently appeared to be the most difficult.

As predicted, the results from all of the analyses indicated that the control and 0 switch conditions led to higher levels of accuracy and shorter RTs. Furthermore, none of the analyses revealed a significant difference between the 0 switch and control conditions. These findings suggest that the presence of a gap (the distance created between the subject and object of the main clause when a sentence contains a relative clause) is not enough to explain why individuals have difficulty understanding sentences containing relative clauses. For example, these results indicate that the 0 switch sentence, *The boy that touched the grandfather kicked the man*, was equally as complex as the control sentence, *The boy next to the grandfather kicked the man*. These findings are contrary to studies suggesting that relative clauses are difficult to process because they create gaps between the main clause subject and the main clause object (Cuetos & Mitchell, 1988; De Vincenzi & Job, 1993). Thus, it appears that other factors, such as perspective shifting, may be involved in the processing of relative clauses.

Although the results from the accuracy (percent correct and d’) and RT analyses were somewhat inconsistent in terms of which relative clause pairs were significantly different from each other, there was a general trend for the 0 switch and 1- relative clauses to yield higher levels of accuracy and shorter RTs. In addition, the d’ analyses used to control for guessing in the accuracy analyses also confirmed a significant difference between the control and 0 switch condition when compared to the 1- condition.
As predicted by MacWhinney’s (2005) Perspective Hypothesis, these findings support that the 0 switch sentences are easier to process than the 1- switch, because in the 0 switch, the perspective of the main clause subject is also the perspective of the relative clause. For example, in the sentence, *The boy that touched the grandfather kicked the man*, the perspective of the main clause subject (*boy*) is maintained throughout the sentence because the boy is also the subject of the relative clause (*that touched the grandfather*). Hence, the results from this study support that the 0 switch sentences are easier to process than 1- switch sentences, because the 0 switch does not require a shift in perspective.

Although the results of this study confirmed MacWhinney’s (2005) Perspective Hypothesis for the 0 switch and 1- conditions, they differed on the 1+ and 2 switch conditions. According to the Perspective Hypothesis, the 1+ relative clause should have yielded the same levels of accuracy and RTs as the 1- switch, while the 2 switch relative clause should have led to the lowest level of accuracy and longer RTs; however, this result was not achieved. In this study, the 1+ and 2 switch sentences seemed to be more difficult. One explanation for this finding could be that the 1+ and 2 switch conditions both contain relative clause requiring backward shifts in perspectives. As seen in Figure 14, the 1+ and 2 switch conditions do not follow the expected left to right word order expected in canonical, S-V-O sentences, where incoming words are usually the object of the words preceding it. Instead, individuals must recognize that the object of the sentence is actually the subject of the relative clause. These findings suggest that the direction of the perspective shift (forward versus backward) also plays a role in relative clause processing.
The sentence type findings from the current study are supported by Weighall and Altmann (2010), who investigated the role of memory capacity in monolingual English-speaking, children’s relative clause attachment preferences. Their results indicated that the children in their experiment had greater difficulty with object-modifying than subject-modifying relative clauses. Moreover, they showed a preference for high attachment (attaching the relative clause to the NP1). These findings suggest that object-modifying relative clauses are more difficult to comprehend than subject-modifying relative clauses.

While the results from the current study are supported by the results obtained by Weighall and Altmann (2010), they contradict from the results obtained by De Vincenzi and Job (1993). The latter investigators found that monolingual, Italian-speaking adults found object-modifying relative clauses to be the easiest to process. One possible explanation for these contradictory results is that the Weighall and Altmann study only considered two types of relative clauses (0 switch and 1- switch sentences). On the other hand, in the current study, four types of relative clauses were examined. It is possible that
by including more complex relative clauses in a task may provide a more complete picture of relative clause processing difficulty.

1+ switch. Although the results from the current study were consistent with the adult study of MacWhinney and Pleh (1988) for the 0 switch and 1- conditions, they differed in that the 1+ condition led to longer RTs than did the other conditions. These findings were not expected, given that MacWhinney and Pleh (1988) suggested that the 2 switch condition would be most difficult and, hence, yield longer RTs. However, the MacWhinney and Pleh study was conducted with Hungarian monolingual adults, making comparisons to child bilingual patterns somewhat spurious.

The results from the current study also differed from Jones (2010), who investigated the effects of perspective shifting in relative clause processing by English-speaking monolingual adults. Jones found that the 1+ condition led to shorter RTs than the rest of the conditions. Furthermore, the results from the current study also differed from the preliminary experiment presented by Wilkinson and colleagues (2008), who found that bilingual children had the least difficulty processing relative clauses containing 0 and 1+ switches. While the current study is a continuation of this project, more linguistic controls were exercised in the generation of the relative clauses used in the current experiment, making comparisons across studies difficult.

One reason that the 1+ switch led to longer RTs in the current study could be that in the 1+ sentence, *The dog chased the cat the horse kicked*, the N1 (dog) and N2 (cat) are both possible agents of the relative clause (i.e., they could potentially be the ones kicking the horse). Thus, it is possible that the participants attached the relative clause to the subject of the main clause and then realized that the relative clause was actually
modifying the N2, or object of the main clause. If the participants completed a second
reanalysis of the sentence, then this would explain why the 1+ switch led to longer RTs
(Weighall & Altmann, 2010). However, in the 2 switch condition, even if the participants
had to complete a backward shift of perspective, attaching the relative clause to the N1
would have led to a correct response.

2 switch. Again, the results from the current study did not support MacWhinney’s
(2005) Perspective Hypothesis, which predicted that the 2 switch condition should have
been the most difficult to process because it contains the most shifts in perspective. The
majority of the analyses revealed that the 2 switch condition was only easier to process
than the control and 0 switch sentences; however, the results from the d’ analysis
comparing the performances across language groups revealed that the participants had
more difficulty with the 2 switch condition than the 1- and 1+ sentences. This finding
suggests that when guessing is accounted for, the participants had difficulty with the 2
switch condition. The variability noted in the participant responses here may have
overshadowed the complexity effect.

Summary. Results from the accuracy, d’, and RT analyses all support that more
complex perspective shifts will be more difficult to comprehend. However, the results
from this study did not support the predicted order of difficulty offered by the Perspective
Hypothesis (MacWhinney, 2005), at least for this sample of children responding to
sentences constructed to control syntactic factors typically used to process relative
clauses. The predicted order was that the SO (2 switch) relative clauses would be more
difficult to comprehend that the OO (1+) relative clause. The current results did not
support this order, suggesting that the direction of the perspective shift (forward versus
backward) and the role of the relative clause (subject versus object-modifying relative clause) may play a larger role in determining the complexity of relative clauses than the number of perspective shifts.

**Bilingual Language Processing of Relative Clauses: Some Theoretical Implications**

One of the most significant findings from the present study was that the bilingual participants performed similarly on tasks of relative clause processing in both of their languages. These findings provide three preliminary theoretical implications in relation to the role of 1) controlling linguistic factors; 2) parallel syntactic structures, and 3) language dominance in bilingual individuals’ processing of relative clauses. These three theoretical implications are discussed in detail below.

**Controlling linguistic factors.** One explanation for this result is that in this study, linguistic factors previously identified as influencing the ease or difficulty of sentence processing were controlled in order to isolate the role of perspective shifting, which is more of a cognitive process, if not a metacognitive process (MacWhinney & Pleh, 1988). For instance, word order was controlled in both languages by using sentences that followed a canonical, S-V-O word order. Second, animacy was controlled in Spanish and English by using animate direct/indirect objects. Finally, memory load was reduced by showing pictures that corresponded to the sentences the participants heard. Controlling for linguistic factors known to influence sentence processing may have permitted the influence of perspective shifting to be isolated, highlighting the possible effects of cognitive processing in the comprehension of complex relative clauses (MacWhinney & Pleh, 1988).
**Parallel syntactic constructions.** It is also possible that the parallel structures resulting from the aforementioned control strategies of sentences in English and Spanish encouraged participants to process both languages in the same way. For instance, perhaps the bilingual participants were using a formula for analyzing syntactic order in Spanish that was similar to English because the sentences in both languages followed an S-V-O word order, which is the favored syntactic structure in English. These findings are consistent with those obtained by MacWhinney and Pleh (1988) who found that Hungarian speakers processed relative clauses containing shifts in perspective in the same way as English speakers when the Hungarian sentences followed a canonical, S-V-O word order; however, differences in relative clause processing were noted when the Hungarian sentences followed a non-canonical word order. These findings provide preliminary evidence that no differences in relative clause processing are noted when the potential influence of the salient feature of a language (i.e., flexible word order) are minimized.

A recent study examining Basque children’s comprehension of relative clauses (Gutierrez-Mangado, 2011) further illustrates how the salient features of language may affect relative clause processing. The results from the present study revealed that in contrast with the results obtained from the present study, the Basque-speaking children had most difficulty with subject-modifying relative clauses. At first glance, these findings appear to be contradictory; however, these differing results highlight that the characteristics of language may influence relative clause processing. For instance, although sentences in Basque follow a canonical word order, the head of the relative clause comes after the relative clause, like in Chinese and Japanese. Therefore, it is
possible that Basque-speaking children had less difficulty comprehending object-modifying relative clauses because relative clauses in Basque are constructed differently than in Spanish and English. So, while the Gutierrez-Mangado results do not seem to support the sentence type differences noted in this experiment, they do suggest that language differences may influence the processing of relative clauses. In general, these findings suggest that similarities in canonical S-V-O word order may not be the only factor influencing relative clause processing, and that the characteristics of a language may also play a role.

**Language dominance.** Another possible explanation as to why the bilingual participants’ performance on the relative clause processing tasks was similar in Spanish and English could be related to language experience and/or language dominance. According to the results of the language questionnaire used in the current study, eight of the 16 participants reported equal dominance in both languages, seven reported English to be dominant, and only one participant reported Spanish to be dominant. In addition, only four of the 16 participants reported attending formal schooling outside of the United States. Moreover, on average, the participants had been speaking English for an average of 3.9 years. Hence, the results from the language questionnaire suggest that the participants in the current study, at a minimum, had relatively adequate experience with academic English.

It is also important to consider that the majority of the participants’ language of schooling was English. The sentences in this study contained complex syntactic structures that are similar to those encountered in academic contexts, like history and science textbooks (Silliman & Scott, 2009). It is possible that since the majority of the
participants in this study had received most of their schooling in the United States, and that many of them reported English to be their dominant language, they have had more exposure to complex syntactic structures in English. Thus, it is feasible that they utilized strategies for analyzing sentences that were more consistent with English in both languages. These findings are in accord with those obtained by Windsor, Kohnert, Lobitz, and Pham (2010), who suggested that bilingual children’s processing of languages might be influenced by their language experiences.

**Clinical and Educational Implications of the Study**

The results of this study have two major implications for clinical and educational practices relating to 1) shared cognitive processes in bilingual individuals and 2) the use of complex syntax in academic language. These implications are discussed below.

**Shared cognitive processes.** First, at least in this sample, bilinguals appeared to share cognitive processes that allowed them to understand their L1 and L2 in the same manner. These findings can be linked with the notions of language performance versus language competence (Kohnert, 2007) in the assessment of bilingual individuals suspected of having a language-impairment. Language performance refers to how an individual speaks or understands a particular language, while language competence refers to the integrity of the cognitive system used in the service of language.

One of the limitations of standardized testing in the assessment of bilingual individuals is that they only focus on testing language performance (Kohnert, 2007). Only examining language performance may lead to misdiagnoses, as an individual’s performance on a specific language measure may be associated with a variety of factors, including socioeconomic status, vocabulary, and background knowledge. However, if an
individual performs poorly in one specific language, this does not mean that he or she lacks the cognitive ability to understand or learn language.

In this study, the bilingual participants came from communities with low socioeconomic status, while the monolingual participants came primarily from a community with a higher economic status. Interestingly, both groups of participants performed similarly on the English relative clauses. It is possible that the equality of the bilinguals’ performance occurred because the experimental tasks examined their relative clause processing at a cognitive, rather than just a linguistic, level. These findings provide evidence that assessing language competence may be a better indicator of bilingual individuals’ language potential, as it reduces some of the bias found in standardized testing in which performance is often related to one’s linguistic experiences as well as socioeconomic status (Kohnert, 2007). Kohnert suggests that that testing cognitive processing may be the key in improving the assessment techniques currently used to assess the language skills of bilingual individuals.

The notion of language competence is further supported by this study, since even some of the bilingual participants that did not perform well on the *CELF-4 Spanish* (Semel et al., 2006) or *CELF-4 English* (Semel et al., 2003) measures, were able to successfully complete the experimental tasks. These findings provide further evidence that the scores individuals obtain on standardized measures may not reflect their competency for understanding complex language. The implication again is that it would be beneficial to create assessments that access cognitive processing (or at least create better comprehension tasks) in order to a form more accurate depiction of the potential bilingual students bring to the language learning process.
**Academic language register and more complex syntax.** The second implication of this study relates to differences in sentence complexity in the oral versus written domain. The oral domain tends to contain simpler syntactic structures, while the written domain, a feature of academic language, is characterized by more complex syntactic structures (Silliman & Scott, 2009). Some of the factors attributable to the complex sentence structures found in written language are the order in which the words appear in the sentence (e.g., canonical S-V-O order versus noncanonical order) and the distance between the crucial words in the sentence (e.g., in the following sentence, nine words interrupt the main clause subject from the verb: *The Union Troops (S) that had just marched across the state of Virginian were (V) tired and sore.* (Silliman & Scott, 2009, p. 116).

While the types of sentences used in this study are usually not encountered in the oral domain, it is likely that students will encounter these more complex sentence types in academic textbooks, like their social studies and science books (Silliman & Scott, 2009). One interesting finding in this study was that the 3rd and 5th grade participants had equal difficulty processing the more complex relative clauses. It is possible that the students had equal difficulty with this task because it was oral and not written. In other words, it is unusual to hear these types of complex sentences. It would be interesting to see if grade differences were more apparent when these complex relative clauses are presented in a written format.
Study Strengths and Limitations

A prominent strength of this study was that it investigated relative clause processing in bilingual speakers’ L1 and L2, while also comparing the processing of Spanish and English relative to monolingual English-speaking peers. Examining sentence processing in bilingual speakers allows for within-subject, cross-linguistic comparisons, while avoiding some of the variability present when comparing sentence processing across studies.

A second strength was that the effects of word order, animacy, and memory load were controlled in order to better isolate the role of perspective shifting. In addition, the pictures used in the experiment were controlled by only including the pictures that 90% or more of graduate students surveyed agreed represented the meaning intended. Controlling for other possible factors affecting relative clause processing allowed for an investigation of the role of perspective shifting in sentence comprehension (MacWhinney & Pleh, 1988). Hence, this is an initial investigation of how processes that occur at a cognitive level, like perspective shifting, affect sentence processing.

A third strength was that, although the sample was relatively small (N=29), the main effect for sentence type was significant with a moderate to large effect size for all of the analyses. These results indicate that the majority of the variability in the results obtained from the analyses was attributable to sentence type. Nonetheless, a larger sample size may reveal greater difficulty with sentences in the 2 switch condition, as suggested by MacWhinney (2005). Moreover, given that the d’ analysis of the bilingual speakers’ L1 and L2 revealed a significant, but small, interaction between language and
sentence type, it is possible that differences across the languages attributable to sentence type would be observed if a larger sample size was recruited.

Finally, the one major limitation of this study was that a monolingual Spanish-speaking group was not included due to practical reasons. This was necessary because finding a sizeable group of monolingual Spanish-speaking children in the United States is improbable. Most likely, finding a group of this kind would necessitate a trip outside of the United States since in the United States, even children with limited English proficiency, have received some level of exposure to English through television, radio, or by interacting with English-speaking individuals.

**Five Directions for Future Study**

The results from this study support that perspective shifting appears to play a role in relative clause processing of bilingual children. Moreover, the results show preliminary evidence that the cognitive processes involved in relative clause comprehension may be universal (MacWhinney & Pleh, 1988). However, further studies need to be completed in order to substantiate the findings of this study.

One direction for future research is to examine perspective shifting across languages in bilingual adults. To date, no research studies have examined the relationship between relative clause processing and perspective shifting in adults who are bilingual. The adults in the MacWhinney and Pleh (1988) study experienced similar difficulties with the relative clauses as the children in this study. Thus, it would be interesting to examine if bilingual adults will also process the relative clause sentences in the same way as the bilingual children in this study.
A second direction for future research is to compare Spanish-English bilingual children’s processing of relative clauses in both languages with a monolingual, Spanish-speaking control group. This type of study may help confirm that, indeed, bilingual and monolingual individuals process sentences in the same way. Understanding how typically developing bilinguals understand language is important, given that not much is known about the underlying language processes that are involved in bilingual individuals’ understanding of sentences. In addition, this type of research may help add to the “developmental data” on sentence processing by typically developing bilingual children. In turn, these data may be helpful in building a foundation for later investigations examining the role of perspective shifting in relative clause processing in bilingual children that are not typically developing, such as those with language impairments, learning disabilities, and Autism Spectrum Disorder (ASD).

The third direction for future study is to examine how the characteristics of a language may influence relative clause processing. In this study, relative clause processing was investigated in two languages that contain similar relative clause constructions. However, the results obtained by Gutierrez-Mangado (2011) suggest that relative clause processing is related to the way that relative clauses are constructed in a language. In order to examine if the results from the present study hold true in languages with different relative clause constructions, it would be important to investigate perspective shifting in the processing of relative clauses by individuals who speak very different languages (e.g., English versus Basque).

The fourth direction for future study is to examine the relationship between second-order false beliefs and perspective shifting. In the current study, all of the
participants passed the two second-order false belief tasks, but few could engage in multiple perspective shifts involving linguistic relations (i.e., backward shifts in perspective). This suggests that the relationship between the concept of second-order false beliefs and linguistically-based perspective taking is far from straightforward. This is another future area for investigation.

The fifth, and final, direction for future study is to examine the relationship between perspective shifting and bilingual speakers’ comprehension of relative clauses by analyzing data that provide information regarding the participants’ on-line processing of the sentences during the experimental tasks. The Mouse Tracker Software (Freeman & Ambady, 2010) that was used to program the experiment also collected data on the participants’ mouse movement trajectories. These mouse trajectories can provide information about the participants’ level of hesitancy when selecting a particular response. For example, if the participants selected a correct response, but their mouse trajectory indicated that they hesitated, this would suggest that the sentence was difficult to comprehend. On the other hand, if the participants selected a correct response, and their mouse trajectories did not indicate hesitation, this would suggest that the sentence was easier to comprehend. Therefore, the investigator intends to analyze the collected mouse trajectories in the near future.
References


Appendices
Appendix A: Participant Demographic Information: Gender and Grade

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<thead>
<tr>
<th>Participant Group</th>
<th>Gender Distribution</th>
<th>Mean Age (years; months); (SD)</th>
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<tr>
<td><strong>Bilingual Participants</strong></td>
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<tr>
<td>3rd graders (n=9)</td>
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<td>8;6 (0.53)</td>
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<td>5th graders (n=7)</td>
<td>4 Females; 3 Males</td>
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<td>9;0 (0.51)</td>
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<td>5th graders (n=6)</td>
<td>3 Females; 3 Males -</td>
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<td>Grand Total (N=29)</td>
<td>16 Females; 13 Males</td>
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## Appendix B: Language Screening Results

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<th>Participant</th>
<th>TOM (%)</th>
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<th>CELF-E Understand Paragraphs</th>
<th>CELF-S Following Directions</th>
<th>CELF-S Understanding Paragraphs</th>
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<td>100</td>
<td>8</td>
<td>8</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>5BF04</td>
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<td>10</td>
<td>9</td>
<td>11</td>
<td>11</td>
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<tr>
<td>5BF05</td>
<td>83</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>5BF16</td>
<td>90</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Mean</td>
<td>93.25</td>
<td>7.75</td>
<td>8.75</td>
<td>10.25</td>
<td>8.25</td>
</tr>
<tr>
<td><strong>Bilingual Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5BM19</td>
<td>75</td>
<td>11</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>5BM31</td>
<td>100</td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Mean</td>
<td>88.3</td>
<td>9.7</td>
<td>10.7</td>
<td>11</td>
<td>9.7</td>
</tr>
<tr>
<td><strong>Monolingual Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5MF32</td>
<td>90</td>
<td>8</td>
<td>14</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>5MF20</td>
<td>100</td>
<td>8</td>
<td>9</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>5MF40</td>
<td>100</td>
<td>8</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Mean</td>
<td>96.7</td>
<td>8</td>
<td>11.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monolingual Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5MM35</td>
<td>100</td>
<td>11</td>
<td>14</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>5MM42</td>
<td>100</td>
<td>11</td>
<td>5</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>5MM43</td>
<td>92</td>
<td>12</td>
<td>14</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Mean</td>
<td>97.3</td>
<td>11.3</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Spanish and English Sentences Used as Stimuli

0 switch and 1-Switch

(Target noun is bold; target verb is underlined)

<table>
<thead>
<tr>
<th>0 Switch (Spanish)</th>
<th>0 Switch (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El niño que tocó al viejo pateó al hombre.</td>
<td>The boy that touched the grandfather kicked the man.</td>
</tr>
<tr>
<td>El hombre que pintó al niño persiguió al policía.</td>
<td>The man that painted the boy followed the policeman.</td>
</tr>
<tr>
<td>El policía que lavó al hombre empujó al niño.</td>
<td>The policeman that washed the man pushed the boy.</td>
</tr>
<tr>
<td>El viejo que empujó al pintor tocó al hombre.</td>
<td>The grandfather that pushed the painter touched the man.</td>
</tr>
<tr>
<td>El pintor que tiró al policía lavó al viejo.</td>
<td>The painter that threw the policeman washed the grandfather.</td>
</tr>
<tr>
<td>La enfermera que tocó a la reina levantó a la bruja.</td>
<td>The nurse that touched the queen lifted the witch.</td>
</tr>
<tr>
<td>La reina que cubrió a la niña pintó a la mujer.</td>
<td>The queen that covered the girl painted the woman.</td>
</tr>
<tr>
<td>La bruja que cargó a la enfermera movió la reina.</td>
<td>The witch that carried the nurse moved the queen.</td>
</tr>
<tr>
<td>La niña que levantó a la mujer cargó a la enfermera.</td>
<td>The girl that lifted the woman carried the nurse.</td>
</tr>
<tr>
<td>La mujer que movió a la reina cubrió a la bruja.</td>
<td>The woman that moved the queen covered the witch.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1-Switch (Spanish)</th>
<th>1-Switch (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El viejo tocó al niño que pateó al hombre.</td>
<td>The grandfather touched the boy that kicked the man.</td>
</tr>
<tr>
<td>El niño pintó al hombre que persiguió al policía.</td>
<td>The boy painted the man that followed the policeman.</td>
</tr>
<tr>
<td>El hombre lavó al policía que empujó al niño.</td>
<td>The man lifted the policeman that pushed the boy.</td>
</tr>
<tr>
<td>El pintor empujó al viejo que tocó al hombre.</td>
<td>The painter pushed the grandfather that touched the man.</td>
</tr>
<tr>
<td>El policía tiró al pintor que lavó al viejo.</td>
<td>The policeman threw the painter that washed the grandfather.</td>
</tr>
<tr>
<td>La reina tocó a la enfermera que levantó a la bruja.</td>
<td>The queen touched the nurse that lifted the witch.</td>
</tr>
<tr>
<td>La niña cubrió a la reina que pintó a la mujer.</td>
<td>The girl covered the queen that painted the woman.</td>
</tr>
<tr>
<td>La enfermera cargó a la bruja que movió a la reina.</td>
<td>The nurse carried the witch that moved the queen.</td>
</tr>
<tr>
<td>La mujer levantó a la niña que cargó a la enfermera.</td>
<td>The woman lifted the girl that carried the nurse.</td>
</tr>
<tr>
<td>La reina movió a la mujer que cubrió a la bruja.</td>
<td>The queen moved the woman that covered the witch.</td>
</tr>
</tbody>
</table>
Appendix C: Continued

1+ Switch and 2 Switch Sentences

(Target noun is bold; target verb is underlined)

<table>
<thead>
<tr>
<th>1+ Switch (Spanish)</th>
<th>1+ Switch (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El hombre tocó al viejo que el niño pateó.</td>
<td>The man touched the grandfather that the boy kicked.</td>
</tr>
<tr>
<td>El policía pintó al niño que el hombre persiguió.</td>
<td>The policeman painted the boy that the man followed.</td>
</tr>
<tr>
<td>El niño lavó al hombre que el policía empujó.</td>
<td>The boy washed the man that the policeman pushed.</td>
</tr>
<tr>
<td>El hombre empujó al pintor que el viejo tocó.</td>
<td>The man pushed the painter that the grandfather touched.</td>
</tr>
<tr>
<td>El viejo tiró al policía que el pintor lavó.</td>
<td>The grandfather threw the policeman that the painter washed.</td>
</tr>
<tr>
<td>La bruja tocó a la reina que la enfermera levantó.</td>
<td>The witch touched the queen that the nurse lifted.</td>
</tr>
<tr>
<td>La mujer cubrió a la niña que la reina pintó.</td>
<td>The woman covered the girl that the queen painted.</td>
</tr>
<tr>
<td>La reina cargó a la enfermera que la bruja movió.</td>
<td>The queen carried the nurse that the witch moved.</td>
</tr>
<tr>
<td>La enfermera levantó a la mujer que la niña cargó.</td>
<td>The nurse lifted the woman that the girl carried.</td>
</tr>
<tr>
<td>La bruja movió a la reina que la mujer cubrió.</td>
<td>The witch moved the queen that the woman covered.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2+ Switch (Spanish)</th>
<th>2+ Switch (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El niño que el viejo tocó pateó al hombre.</td>
<td>The boy that the grandfather touched kicked the man.</td>
</tr>
<tr>
<td>El hombre que el niño pinto persiguió al policía.</td>
<td>The man that the boy painted followed the policeman.</td>
</tr>
<tr>
<td>El policía que el hombre lavó empujó a la niña.</td>
<td>The policeman that the man washed pushed the boy.</td>
</tr>
<tr>
<td>El viejo que el pintor empujó tocó al hombre.</td>
<td>The grandfather that the painter pushed touched the man.</td>
</tr>
<tr>
<td>El pintor que el policía tiró lavó al viejo.</td>
<td>The painter that the policeman threw lifted the grandfather.</td>
</tr>
<tr>
<td>La enfermera que la reina tocó levantó a la bruja.</td>
<td>The nurse that the queen touched lifted the witch.</td>
</tr>
<tr>
<td>La reina que la niña cubrió pintó a la mujer.</td>
<td>The queen that the girl covered painted the woman.</td>
</tr>
<tr>
<td>La bruja que la enfermera cargó movió la reina.</td>
<td>The witch that the nurse carried moved the queen.</td>
</tr>
<tr>
<td>La niña que la mujer levantó cargó a la enfermera.</td>
<td>The girl that the woman lifted carried the nurse.</td>
</tr>
<tr>
<td>La mujer que la reina movió cubrió a la bruja.</td>
<td>The woman that the queen moved covered the witch.</td>
</tr>
</tbody>
</table>
Appendix C: Continued

Control Sentences

(Target noun is bold; target verb is underlined)

<table>
<thead>
<tr>
<th>Control (Spanish)</th>
<th>Control (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El niño detrás del viejo pateó al hombre.</td>
<td>The boy behind the grandfather kicked the man.</td>
</tr>
<tr>
<td>El hombre al lado del niño persiguió al policía.</td>
<td>The man next to the boy followed the policeman.</td>
</tr>
<tr>
<td>El policía arriba del hombre empujó al niño.</td>
<td>The policeman on top of the man pushed the boy.</td>
</tr>
<tr>
<td>El viejo delante del pintor tocó al hombre.</td>
<td>The grandfather in front of the painter touched the man.</td>
</tr>
<tr>
<td>El pintor cerca del policía lavó al viejo.</td>
<td>The painter near the policeman washed the grandfather.</td>
</tr>
<tr>
<td>La enfermera sobre la reina levantó a la bruja.</td>
<td>The nurse above the queen lifted the witch.</td>
</tr>
<tr>
<td>La reina al frente de la niña pintó a la mujer.</td>
<td>The queen across from the girl painted the woman.</td>
</tr>
<tr>
<td>La bruja encima de la enfermera movió a la reina.</td>
<td>The witch on top of the nurse moved the queen.</td>
</tr>
<tr>
<td>La niña abajo de la mujer cargó a la enfermera.</td>
<td>The girl under the woman carried the nurse.</td>
</tr>
<tr>
<td>La mujer lejos de la reina cubrió a la bruja.</td>
<td>The woman far from the queen covered the witch.</td>
</tr>
</tbody>
</table>
Appendix D: Second-Order Theory of Mind: Logical and Social Inferencing Tasks

(Adapted from Silliman, Diehl, Bahr, Hnath-Chilsom, Zenko, Friedman, 2003)

I. Second-order false belief logical inferencing task (Pam’s story)

**Implicit False Belief** (modified from Sullivan et al., 1994):
This is a story about Pam and her Dad. Today is Pam’s birthday and she’s having a big party tonight. Dad is surprising her with a new bike that he has hidden in the living room. See? Here is the surprise bike. Pam and Dad are in the kitchen talking about her birthday. Pam says, “Dad, I really want a new bike for my birthday.” Now remember, Dad wants the bike to be a surprise, so he says, “Sorry, I didn’t get you that. I got you roller blades instead.”

**First-Order Question:** What does Pam think Dad got her for her birthday? (If necessary, fill in: Pam thinks Dad got her ___. Forced choice: Pam thinks Dad got her a bike for her birthday or Pam thinks Dad got her roller blades for her birthday.)

**Reality Question:** What did Dad really get her for her birthday? (If necessary, fill in: Dad really got Pam ___. Forced choice: Dad really got Pam a bike for her birthday or Dad really got Pam roller blades for her birthday.)

**Linguistic Contrast Question:** Does Dad know that Pam saw her bike in the living room? Later, Pam’s grandmother comes over for the party. Grandma asks Dad, “Does Pam know what you got her for her birthday?”

**Ignorance Question:** What does Dad say? (If necessary, fill in: Dad says ___. Forced choice: Does Dad say, “Yes, Pam knows what I got her for her birthday” or “No, Pam does not know what I got her for her birthday?”) Now remember, Dad does not know that Pam saw what he got her for her birthday. Then Grandma asks Dad, “What does Pam think you got her for her birthday?”

**Second-Order Question:** What does Dad say? (If necessary, fill in: Dad says, “Pam thinks I got her ___.” Forced choice: Does Dad say, “Pam thinks I got her a bike” or “Pam thinks I got her roller blades”?)

**Justification Question:** Why does Dad say that?

II. Second-order false-belief social inferencing task (Frank’s story)
Implicit False Belief: This is a story about Frank and his Dad. Today is Frank’s birthday. Frank wants to go to a baseball game for his birthday. He does not want a surprise party for his birthday. Frank hates surprise parties. He gets embarrassed when everyone looks at him and yells “Surprise!” Frank’s Dad is giving him a surprise birthday party. Dad bought Frank balloons and a birthday cake and hid them in the living room. Dad does not know that Frank gets embarrassed at surprise parties. Dad thinks Frank would be glad to have a surprise party. Frank and Dad are in the kitchen talking about his birthday. Frank says, “Dad I really want to go to a baseball game for my birthday.” Now remember, Dad wants the party to be a surprise, so he says, “Frank, that’s a good idea. I will think about it.”

First-Order Question: What does Frank hope that Dad will do for his birthday? (If necessary, fill in: Frank hopes that Dad will _____). Forced choice: Does Frank hope that Dad will take him to a baseball game for his birthday or does Frank hope that Dad will give him a surprise party for his birthday?)

Reality Question: What did Dad really do for Frank’s birthday? (If incorrect, say: “But remember, Dad wants to surprise Frank with the party.” If necessary, fill in: Dad really _____. Forced choice: Dad really got tickets for a baseball game for Frank’s birthday or Dad really planned a surprise party for Frank’s birthday). Then Frank says to Dad, “Great, I’m going to tell my friend next door, I’ll be home later.” On his way out, Frank sees the balloons and cake hidden in the living room. He thinks, “Oh no! Dad is giving me a surprise party; we are not going to the baseball game.” Remember, Dad does not see Frank go into the living room and find the balloons and cake.

Linguistic Contrast Question: Does Dad know that Frank is disappointed? (If necessary, fill in: n/a. Forced choice: Yes, Dad knows Frank is disappointed or No, Dad does not know Frank is disappointed. If wrong, say, “But remember, Dad does not see Frank go into the living room and find the balloons and cake.”) Later, Frank’s grandmother comes over for the party. Grandma asks Dad, “Does Frank like surprise parties?”

Ignorance Question: What does Dad say? (If necessary, fill in: Dad says ___. Forced choice: Does Dad say, “Yes, Frank likes surprise parties” or “No, Frank does not like surprise parties”? Now remember, Dad does not know that Frank gets embarrassed at surprise parties. Then Grandma asks Dad, “How will Frank feel about having a surprise party?”

Second-Order Question: What does Dad say? (If necessary, fill in: Frank will be ____. Forced choice: Does Dad say, “Frank will be glad to have a surprise party” or “Frank will be embarrassed to have a surprise party”?)

Justification Question: Why does Dad say that?
Appendix E: English Language-Use Questionnaires

Dear Parent(s) or Legal Guardian(s):

Please complete the following questionnaire regarding your child’s language use at home. The information collected from this questionnaire will only be used for the purpose of the study and will not be shared with anyone in the school who is not directly related to the study. Thank you for your help in making this project possible!

1. What language(s) are spoken at home?


***If more than one language is spoken at home, please continue answering questionnaire.***

2. If more than one language was indicated above, how often is each language spoken at home? (Please select an answer for each language).

<table>
<thead>
<tr>
<th>English</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Always</td>
<td>[ ] Always</td>
</tr>
<tr>
<td>[ ] Sometimes</td>
<td>[ ] Sometimes</td>
</tr>
<tr>
<td>[ ] Rarely</td>
<td>[ ] Rarely</td>
</tr>
<tr>
<td>[ ] Never</td>
<td>[ ] Never</td>
</tr>
</tbody>
</table>

3. Please select the best answer in regards to when your child learned English/Spanish (Please select an answer for each language):

<table>
<thead>
<tr>
<th>English</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Same time as Spanish</td>
<td>[ ] Same time as English</td>
</tr>
<tr>
<td>[ ] After learning Spanish</td>
<td>[ ] After learning English</td>
</tr>
</tbody>
</table>

4. How long has your child spoken:
   English: _________________________________
   Spanish: _________________________________
5. Which language would you consider your child to be stronger in? (Please select one answer)

[ ] English
[ ] Spanish
[ ] English and Spanish are the same

6. Please state the country in which your child and/or child’s family is from (Select all the answers that apply):

[ ] Colombia
[ ] Cuba
[ ] Dominican Republic
[ ] El Salvador
[ ] Honduras
[ ] Mexico
[ ] Puerto Rico
[ ] Other/Specify: __________________________

7. Did your child attend school outside of the United States? (Please select one)

[ ] yes [ ] no

If yes, how long? ________________________________

What grades? ________________________________
Appendix F: Spanish Language-Use Questionnaires

Querido Padre(s) o Guardian(s):
Por favor, complete el siguiente cuestionario sobre el uso del lenguaje de su hijo en casa. La información recogida en este cuestionario será utilizada solamente para el propósito del estudio y no será compartida con nadie en la escuela que no está directamente relacionada con el estudio. ¡Gracias por su ayuda en hacer posible este proyecto!

1. ¿Qué lenguaje(s) hablan en su hogar?

*** Si más de un idioma se habla en casa, por favor continúe respondiendo al cuestionario.***

2. Si mas de un lenguaje se habla en casa, ¿Con cuanta frecuencia se habla cada idioma en la casa? (Por favor seleccione una respuesta para cada lenguaje)

<table>
<thead>
<tr>
<th>inglés</th>
<th>español</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Siempre</td>
<td>[ ] Siempre</td>
</tr>
<tr>
<td>[ ] Algunas veces</td>
<td>[ ] Algunas veces</td>
</tr>
<tr>
<td>[ ] Raramente</td>
<td>[ ] Raramente</td>
</tr>
<tr>
<td>[ ] Nunca</td>
<td>[ ] Nunca</td>
</tr>
</tbody>
</table>

3. Por favor seleccione la mejor opción sobre cuando su hijo(a) aprendió inglés/español.

<table>
<thead>
<tr>
<th>inglés</th>
<th>español</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] A la misma vez que español</td>
<td>[ ] A la misma vez que inglés</td>
</tr>
<tr>
<td>[ ] Después de aprender español</td>
<td>[ ] Después de aprender inglés</td>
</tr>
</tbody>
</table>

4. Por cuánto tiempo su hijo(a) a hablado:
   inglés: ______________________________
   español: ______________________________

5. ¿Qué lenguaje usted diría que su hijo(a) habla/entiende mejor? (Por favor seleccione su respuesta)
[ ] inglés
[ ] español
[ ] inglés y español son iguales

6. Por favor seleccione de que país su hijo(a) y/o su familia son originalmente.
   (Seleccione todas las respuestas que apliquen).
   [ ] Colombia
   [ ] Cuba
   [ ] Republica Dominicana
   [ ] El Salvador
   [ ] Honduras
   [ ] Mexico
   [ ] Puerto Rico
   [ ] Otro/Especifique: __________________

7. ¿Su hijo(a) ha asistido a la escuela fuera de los Estados Unidos?
   (Por favor seleccione su respuesta)

   [ ] si [ ] no

Si respondió “sí,” ¿Por cuánto tiempo? ______________________________
¿Qué grados? ______________________________
Appendix G: Investigator Instructions to Participants

Practice Examples

NOW WE ARE GOING TO TALK IN SPANISH (ENGLISH) JUST LIKE WE DO (AT HOME OR WITH OUR FRIENDS) (AT SCHOOL).

- You are going to see two pictures on the computer and you will hear a lady saying a sentence through the earphones. You will see two pictures that will show what’s happening for each sentence. Please tell me if the two pictures on the screen correctly demonstrate the person doing the action in the sentence.
- Do not focus on the shades in the color of the characters in the pictures.
- Look at the two pictures and listen very carefully to what the lady says.
- If you don’t hear what the lady says, then tell me. I will get the lady to say the sentence one more time.
- Let’s look at the picture and hear what the lady says.

PICTURE COMES UP WITH SENTENCE

- The lady said “The boy pushed the man that kicked the policeman.” (GUIDE CHILD EYES ACROSS BOTH PICTURES). Now think. When the lady said “The boy pushed the man kicked the dog,” was she telling the truth about what happened?
- If the lady told the truth, then click on yes using your mouse. (POINT TO BUTTON)
- If the lady did not tell the truth, press no using your mouse. (POINT TO BUTTON)
- How did you pick your answer?
- Great! You really got it. Now let’s practice with a few more pictures. Remember…..if the lady tells the truth about what happened in the pictures, click on yes. If the lady did not tell the truth about what happened in the pictures, click on no. Do you have any questions about how we play this game?

PUT ON EARPHONES TO ADJUST VOLUME

- TRIAL SECTION: IF CHILD DOES NOT APPEAR TO UNDERSTAND THE TASK
  - Remember, listen to the whole sentence before answering
  - If the picture you see matches the sentence, click on “yes”
  - If the picture you see does not match the sentence, click on “no”
  - Remember, don’t focus on the colors in the characters being different TASK

PRESENTATION

- Now you are really ready to play our game.
- Click on start to see the pictures and hear the lady describe what’s happening in the pictures.
- You will still click on yes if what the lady says is true about the persons doing the actions in the sentences and you will click on no if what the lady says is not true.
- The lady may try to trick you. What she says may get harder to figure out. But I know you won’t let her trick you.
- One more thing, make sure to keep your hand on the mouse at all times so you’re ready to answer.
- Ready?...Let’s get started!